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MONTHLY WEATHER REVIEW

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A SEMI-QUANTITATIVE METHOD OF FORECASTING SUMMER STRATUS IN NORTH AMERICAN TROPICAL MARITIME AIR

By J. J. GEORGE and W. M. BRADLEY

[Eastern Air Lines, Hapeville, Ga., December 1936]

Of all North American air masses, probably the least variance in properties is observed in Tropical Gulf and Tropical Atlantic air (1). About the only marked variation noticed is the elevation at which the so-called Superior (2) air is encountered; and even this variation is of little or no significance for the subject under discussion. Because of this uniformity, these air masses (hereafter referred to collectively as Tropical Maritime air, since they are practically indistinguishable) should prove particularly amenable to a quantitative method of forecasting the attendant stratus deck.

During the summer, Tropical Maritime (TM) air is markedly unstable and is characterized by daytime cumulus, showers, and thunderstorms within the air mass. This is typical of a "Cold" air mass. "Cold" is used here in the same sense as in Bergeron's classification, i. e., the air is colder than the surface over which it is moving; it is therefore warmed from below, and instability results. Petterssen (3) and Vernon (4) have explained the California stratus as a result of such instability. This explanation does not, however, hold for the stratus formed in TM air because ordinarily no pronounced inversion is present at low levels to limit convection. During the night the lower layers of the air are cooled somewhat by radiation, and some stabilization takes place, as is shown by the cessation of the thunderstorms and by the normally clear nights.

Radiation or ground fogs of any intensity are practically unknown in this air mass in summer. The large moisture content (about 18 gr/kg at the surface) effectively limits radiation; and the diurnal temperature range in TM air is consequently very small, rarely amounting to more than 15° or 18° F. On the other hand, stratus fogs are common to the air mass, occurring frequently and covering large areas. The area visited by these fogs includes all the inland areas reached by the air mass itself, most commonly south of the 35th parallel and east of the 100th meridian. The actual formation of the fog may be, and often is, extremely rapid. Airline pilots flying in the area state that at times, when flying in clear air with the ground perfectly visible, the fog may form solidly below them during the time necessary to make a notation on the ship's papers. Although this type of stratus is important to airline operation, it is more important to the itinerant flyer not so familiar with local navigation aids and conditions, for the reason that almost invariably a ceiling is left under the fog layer, seldom if ever decreasing to less than 300 feet (sufficient for experienced pilots at most airports in the affected area); in addition, visibility is always good under the fog, so that, in general, aviation difficulties are only moderate.

Unfortunately, records of airplane soundings for this area were not readily available for previous years, and during the summer of 1936 a minimum of this type of stratus was observed east of the Mississippi River. For this reason the soundings presented here are limited to one station, San Antonio, Tex., and are for only the summer of 1936. They are, however, typical of the few soundings from Shreveport, La., and Montgomery, Ala. Even with limited aerological material, it is easy enough to obtain a fairly representative picture of the vertical distribution of temperature and moisture for various conditions of fog formation. Figure 1 shows four typical soundings represented on an ordinary temperature-elevation chart. The lapse rates in the turbulence layers all lie between 5° and 6° C per km, a value greater than the moist adiabatic for the high temperatures involved. The moisture distribution (not shown) is typical of a turbulence layer; that is, the specific humidity is nearly constant at a high value up to the base of the inversion, where it decreases slightly. The relative humidity is high throughout the layer but reaches a maximum at the base of the inversion. Table 1 compares the inversion base in these ascents with the pressure gradients and stratus formations.

TABLE 1

Curve	Height above ground of inversion base	Geostrophic wind from isobars of 2000 chart preceding night	Geostrophic wind from following 0800 chart	Cloud deck
	Meters	*Force Beaufort*	*Force Beaufort*	
I	Zero	Near zero	Near zero	Clear.
II	200	5.6	5.3	0.6 ST between 0600 and 0800 hours. Elevation unknown.
III	600	8.0	5.3	Broken stratus base 250; top 610 meters.
IV	1,180	7.5	6.7	Solid stratus base; top 1,000 meters

Since ground fog of any intensity is almost unknown in this air mass, it follows that radiation alone is too ineffective to produce, or even to be a decisive factor in, the formation of the stratus deck. For this reason, attention is logically turned to the only factor present in the stratus formation which is absent when conditions are ideal for ground fog formation—a turbulence-produced inversion.

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The soundings in figure 1 show the small magnitude of the inversion, and, to some extent, the relation between the elevation of the base of the inversion and the pressure gradient. It should be noted that for calm conditions the inversion is a surface one of small magnitude; as the velocity increases, the base of the inversion is forced upward, but the inversion produced is of the order of only 1° C. This small value is to be expected, considering the originally rather steep lapse rate in this air mass.

Having arrived at the tentative conclusion that turbulence is the necessary factor in the formation of the stratus

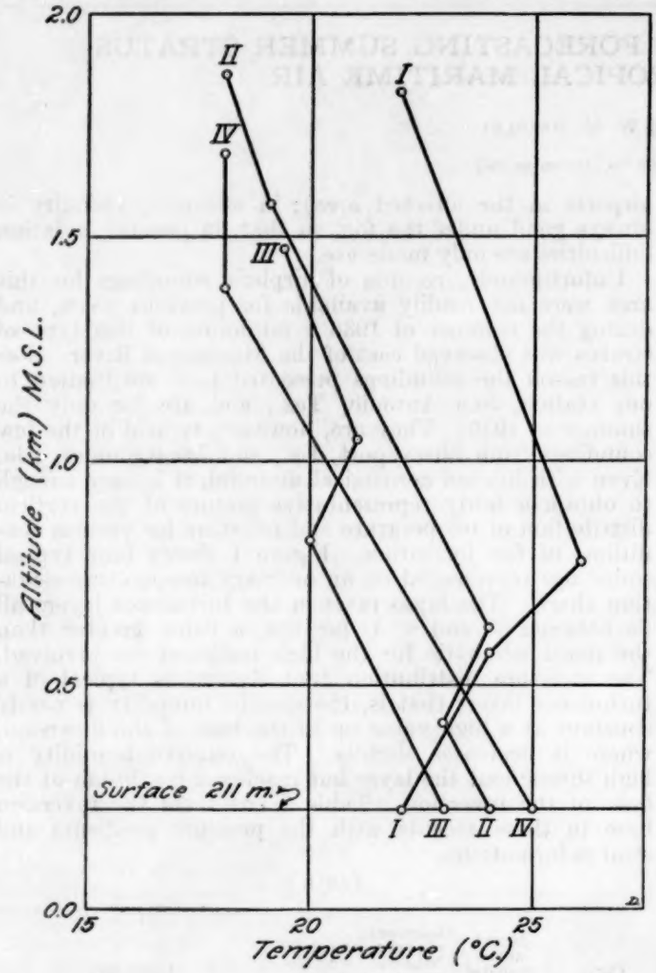


FIGURE 1.

and having verified the existence of such a turbulence layer from airplane soundings, we still must prove this conclusion and ascertain whether the stratus layer can be forecast by means of the condition that causes it. Rossby and Montgomery (5) indicate that for a given roughness parameter, the height of the layer of frictional influence is directly proportional to the wind speed at anemometer level. Although it should be possible to proceed along these lines, using the wind at anemometer level, a great deal of research at each individual station would be necessary to determine the indiviudal roughness factor. In addition, anemometer readings are not made with the precision which would be essential to use in these computations. Hence it was not considered practical to proceed on the basis of anemometer data.

Some measure of wind velocity however, is obviously the logical method of attack upon this problem of the formation of a turbulence inversion. The forecasters at the airway forecast center at Atlanta have long recognized that on nights when the stratus appeared the evening balloon run showed a definite maximum of velocity between 1,000 and 3,000 feet above the surface. This fact, of course, conforms to the well known Ekman spiral, and provides a close approximation to the gradient wind (6). Accordingly, a dot graph (fig. 2) was prepared by plotting wind direction against velocity at approximate gradient level as determined from the evening balloon runs at the Atlanta, Ga., airport station. The circles indicate nights on which no fog was observed; crosses, nights on which stratus formed; and diamonds, cases in which the stratus never became solid overcast. No case of formation of a stratus condition was noted for wind directions between east and west through north, partly because mari-

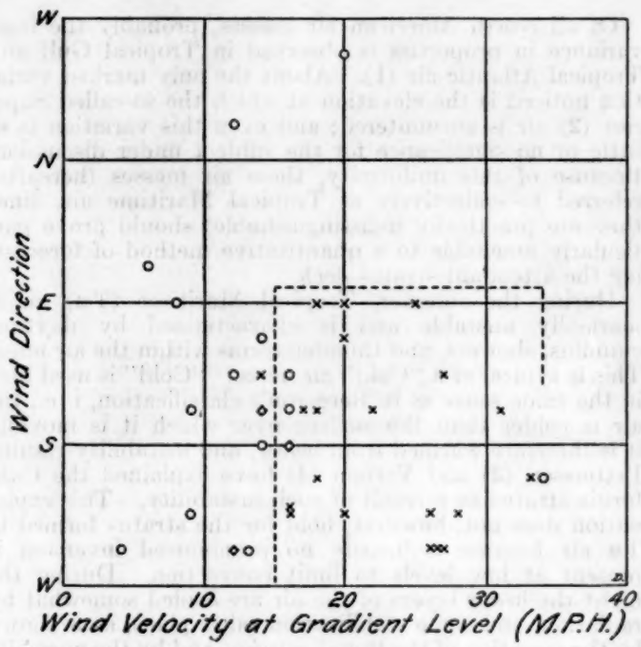


FIGURE 2.

time tropical air seldom if ever travels southward against the normal monsoon with sufficient velocity to establish the necessary turbulence layer, and partly because of slight foehn effect at Atlanta of winds from the northwest quadrant.

An amazingly sharp division between nights with, and nights without, the fog is immediately evident at a critical velocity of 15 m.p.h.; out of a total of 37 cases in which Tm air was present, only 3 are not thus segregated, and in each of these cases the wind velocity was not more than 1 m.p.h. from the critical velocity. A minimum velocity of about 15 m.p.h. must be attained before a turbulence layer, and consequently a stratus condition, can be formed. One case of no fog formation that occurred with a velocity of 34 m.p.h. will be covered in later paragraphs.

If, instead of plotting wind velocity against direction, we plot wind velocity against time of fog formation, we obtain figure 3. A smooth curve somewhat resembling an exponential curve is suggested, and has been drawn in the figure asymptotic to the critical velocity of 15 m. p. h. It should be noted that the time of actual formation of

the stratus deck was in no case farther away from the curve than 2½ hours, and that the average is about 40 minutes. Such a relation is far too close to be coincidence; it seems justifiable to conclude that we have here ample confirmation of the original hypothesis, and at the same time a simple, accurate and direct method of forecasting the occurrence of the fog. This curve also explains the lack of fog formation for a velocity of 34 m. p. h. mentioned previously—the corresponding time of formation read from the figure is 0715, which in summer is so late that the sun has already destroyed the inversion produced by turbulence.

At velocities below 15 m. p. h., the turbulent layer is so shallow as to be negligible. The earliest times of fog formation should be expected with the lowest wind velocities, because mixing at the inversion surface is small and also because complete mixing in the homogeneous layer is

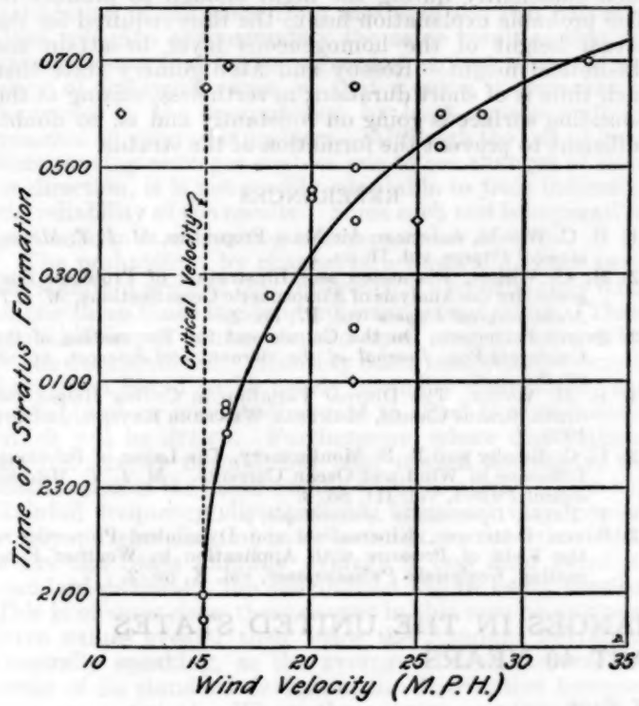


FIGURE 3.

more rapidly attained for the shallower layers. This statement is true under the logical assumption that the formation of the turbulence layer can begin only near sunset. That it cannot begin earlier is apparent from the unstable character of the air, which has no inversion to limit convection caused by either heating or turbulence. As velocities increase, turbulence extends higher, and a correspondingly longer time is required to form the thicker homogeneous layer. Nocturnal radiation of course assists in the formation of the stratus layer, since the latter forms only at night, but such assistance is comparatively minor because the extremely high moisture content limits the radiation; certainly its effect is quite uniform because of the homogeneity of the air mass.

A number of other interesting facts connected with the formation became apparent when the data were examined closely. It is true (fig. 3) that between the hours of 8:30 p. m. and 12:30 a. m., the curve has too great a slope for accurate determination of the time of fog formation; but this fact becomes of minor importance when it is considered that fogs which form early (before 2300 C. S. T.) are very likely to remain broken until well after midnight. This, too, is logical, since turbulence has not then had time in some places to form a pronounced inversion, while it has in other places, because of a slightly different character of terrain perhaps. Fogs which form late (after 0500) are also likely to remain broken, because of mixing by the attendant high wind velocities, heating of ground, and austausch.

Figure 4 shows an apparent relation between wind velocity and time of breaking of the stratus deck, for different approximate elevations of the base of the inversion. Unfortunately, the data are not sufficiently numerous to portray the actual relation. There should be very little relation between these two elements at the higher inversion levels, because of the indeterminate austausch taking place at the correspondingly high velocities, as well as other factors which cannot readily be measured; with only lower turbulent layers, mixing is slight and hence more regularity should be noted. The family of

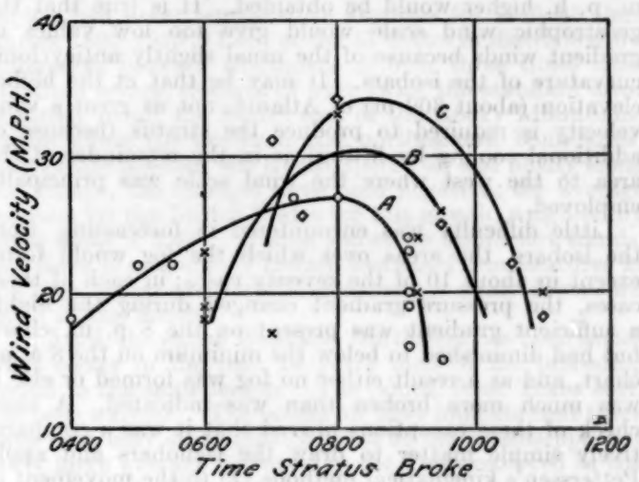


FIGURE 4.

curves in figure 4, marked A, B, and C, respectively, represent the relation for the approximate gradient levels of 1,500, 2,000, and 3,000 feet. Wind velocities are plotted as ordinates, and the times the stratus deck began to dissolve as abscissae. Circles represent an approximate elevation of the base of the inversion of 1,000 to 1,500 feet, crosses 1,500 to 2,500 feet, and diamonds 2,500 to 3,500 feet. For the lower levels—i. e., 1,000 to 1,500 feet—the curve fits the data so well that there can be little doubt that some such relation exists. For the higher levels, however, curves B and C were drawn from curve A as a pattern as much as from the actual data. Theoretically, we should expect only one time of breaking to be associated with one velocity. The fact that these curves seem to indicate definitely two possible times does not necessarily mean the theory is wrong. Rather, the few observations on the ascending branch of the curve indicate abnormal conditions of formation where the gradient wind is in the process of either increasing or decreasing. Even considering the numerous sources of inaccuracy here, it is probable that with more data and more airplane observations these curves would be verified.

It sometimes happens that balloon runs are not available for areas in which forecasts are desired. In view of this, some seventy analyzed 2000 E. S. T. charts, for the summers of 1935 and 1936, which contained TM warm

sectors were examined. The isobars for these sectors were redrawn with extreme care (all available airway reports were used, making a rather close network of reporting stations). A geostrophic wind scale constructed from the well-known approximate formula, $G=\frac{\Delta P/\Delta S}{\rho.2\omega\sin\phi}$, where G is the geostrophic wind, $\frac{\Delta P}{\Delta S}$ the pressure gradient, $2\omega\sin\phi$ the apparent deflective force of the earth's rotation, and ρ the density of air. By applying the scale to the isobars, the theoretical geostrophic wind velocity may be read off directly in force Beaufort. A thorough check of these charts showed almost as definitely a critical velocity as the pilot balloon data. The velocity by this method was found to be half way in force 5 Beaufort, about 21 m. p. h., a value slightly higher than that determined by the balloon runs. It is probable that the explanation for the higher value is partly the method of determining the gradient wind from the balloon runs: If precision methods were employed, values about 2 m. p. h. higher would be obtained. It is true that the geostrophic wind scale would give too low values of gradient winds because of the usual slightly anticyclonic curvature of the isobars. It may be that at the higher elevation (about 300 m) of Atlanta, not as great a wind velocity is required to produce the stratus (because of additional cooling by lifting) as in the remainder of the area to the west where the wind scale was principally employed.

Little difficulty was encountered in forecasting, from the isobars, the areas over which the fog would form, except in about 10 of the seventy cases; in each of these cases, the pressure gradient changed during the night; a sufficient gradient was present on the 8 p. m. chart, but had diminished to below the minimum on the 8 a. m. chart, and as a result either no fog was formed or else it was much more broken than was indicated. A close check of these exceptions proved that it was a comparatively simple matter to draw the isallobars and apply Petterssen's kinematical methods (7) to the movement of isobars; since the extreme horizontal homogeneity in TM air (1) demands parallel isobars, and since we are only interested in their relative movement, the computations are so simplified that they may in most cases be done by inspection. The appropriate formula is $h=h_0+(C_2-C_1)t$, where h_0 is the original distance between isobars, h is the distance after a time t, and C refers to the instantaneous velocity of isobars 1 and 2. The velocity of an isobar is $C_t=-Th$, where T is the three hour pressure tendency. With sufficient accuracy for our purposes, the unit distances may, in most cases, be considered equal for the neighboring isobars; this assumption permits a simple subtraction of pressure tendencies at the two isobars, which is then multiplied by 4 in order to obtain the spreading of the isobars between the two 12 hour charts.

It is interesting to note that in no case was there observed a condition where the gradient was insufficient on the 8 p. m. map to produce the stratus and had strengthened sufficiently during the night enough to produce it. The probable explanation lies in the time required for the actual height of the homogeneous layer to attain the theoretical height. Rossby and Montgomery state that such time is of short duration; nevertheless, mixing at the bounding surface is going on constantly and is, no doubt, sufficient to prevent the formation of the stratus.

REFERENCES

(1) H. C. Willett, American Air Mass Properties, *M. I. T. Meteorological Papers*, vol. II, no. 2.
(2) H. C. Willett, Discussion and Illustration of Problems Suggested by the Analysis of Atmospheric Cross Sections, *M. I. T. Meteorological Papers* vol. IV, no. 2.
(3) Sverre Petterssen, On the Causes and the Forecasting of the California Fog, *Journal of the Aeronautical Sciences*, vol. 3, no. 9.
(4) E. M. Vernon, The Diurnal Variation in Ceiling Height Beneath Stratus Clouds, MONTHLY WEATHER REVIEW, January 1936.
(5) C. G. Rossby and R. B. Montgomery, The Layer of Frictional Influence in Wind and Ocean Currents. *M. I. T. Meteorological Papers*, vol. III, no. 3.
(6) F. Exner, *Dynamische Meteorologie*, p. 121.
(7) Sverre Petterssen, Kinematical and Dynamical Properties of the Field of Pressure with Application to Weather Forecasting, *Geofysiske Publikasjoner*, vol. X, no. 2.

TEMPERATURE AND RAINFALL CHANGES IN THE UNITED STATES DURING THE PAST 40 YEARS

By LARRY F. PAGE

[Bureau of Agricultural Economics, Washington, D. C., December 1936]

About 3 years ago, Kincer (1) showed that the annual average temperature at a number of stations in the United States and elsewhere had been rising for a period of 20 to 30 years or more. For a few records, the four quarters of the year were separated, and the results indicated some differences in trends. A recent publication of the U. S. Geological Survey (2) includes an examination of precipitation trends at stations grouped in 15 sections of the United States, by three seasons, December to April, May to August, and September to November. Ten-year moving averages were used, and indicated upward trends in the fall, and declining trends in winter and summer precipitation [(2), p. 48]. The question naturally arises as to the similarity of trends among the months, within the seasons. Since the divisions of the year, as used in these studies, represent somewhat different types of weather influence, it might be reasonable to assume that the variations in trend were due to these differences. We might expect, at least, a shading from one average seasonal trend to the next for the same station or area.

To investigate this, State monthly average temperature and precipitation records were used, as published in *Climatological Data* by the U. S. Weather Bureau. In order to simplify calculation and comparison, only data for the years 1896 to 1935, inclusive, were used with the exception of California, where the published records begin with 1897. No indication is given, from this study, as to the future trend. Such changes as are shown might be due to fluctuations or periodicities of about 40 years *or longer*, or to more or less permanent changes in our climate. This 40-year period was divided into two series of 20 years each, 1896 to 1915 and 1916 to 1935. The mean value and standard deviation[1] for each of these series for each State were computed, and from the latter

[1] Standard deviations were computed by the formula $\sigma_{x_1}=\sqrt{\frac{(\Sigma x_1-\bar{x}_1)^2}{n_1}}$. Preference is often given to the formula using $n-1$ in place of n, but differences are small, and certain considerations indicated the use of the former. See (3), p. 51.

the standard errors of the differences between the means for the two series were obtained from the formulas (3):

$$\sigma_{M_1-M_2}=\sqrt{\sigma_{M_2}^2+\sigma_{M_1}^2}, \qquad \sigma_{M_1}=\frac{\sigma_{x_1}}{\sqrt{n_1}}$$

where M_1 and σ_{x_1} are the mean and standard deviation, respectively, of the series 1896–1915.

It must be kept clearly in mind that the comparisons given below are based on differences between averages over arbitrarily chosen periods. A longer or a shorter period might show a trend in the opposite direction; and variations of short duration may be obscured.

The reasons for adopting this method of analysis are its susceptibility to statistical test and its ease of calculation compared to fitting least square lines. If the data, exclusive of "random" fluctuations, lie on a straight line, calculation of the slope from means of the two halves of data will give approximately the same result as that obtained from a first degree regression against time. If the slope of the trend varies, so that a curve is necessary to represent it, the computation by least square methods presents an enormous problem. Although the use of long-time moving averages enables one to see changes of slope or direction, it is not readily adaptable to tests indicating the reliability of the results. Some such test is imperative, particularly in evaluating a large number of series.

The probability, by chance, of a mean difference twice the standard error of that difference is approximately 0.05; of one three times its standard error, about 0.005. These probabilities, of course, depend upon normal distribution of the data involved. Monthly State temperature records have been found to be nearly normally distributed, and probably never enough divergent to affect the conclusions which will be drawn. Furthermore, where distributions are not exactly normal, but tend toward normality, the distribution of the mean usually tends to normal [(3), p. 99]. Rainfall frequency distributions, however, vary considerably. Generalization may be made to the extent that where the State monthly average is less than twice its standard deviation, the distribution will be badly skewed. This is obvious since there cannot in this case be any negative values greater than twice the standard deviation. Generally speaking, as the average rainfall increases in terms of its standard deviation, the distribution becomes more symmetrical. Where the average monthly rainfall is more than twice its standard deviation, errors in interpretation due to non-normal distribution should be small and no doubt less than other unavoidable errors in the data itself.

Tables 1 and 2 show, for temperature and rainfall, respectively, the 1916–35 average minus the 1896–1915 average. Values more than twice their standard errors are in italics, and those more than three times their standard errors in bold face. Precipitation differences which appear to be significant, but where the distribution is clearly not normal, are shown in parentheses.

The values shown in tables 1 and 2 are plotted on figures 1 and 2, and on 3 and 4, respectively. The solid straight line is at zero change, and the dashed straight line is the average *annual* change from the 1896–1915 average to that for 1916–35. Where the dashed line is not shown, it was so close to zero that it could not be clearly plotted. The irregular lines indicate the annual march of temperature and precipitation *trends*. Monthly differences which are over twice their standard errors are marked o; those over three times their standard errors are marked x.

Different sections of the country appear to have characteristic patterns of changes in monthly temperature averages. In the South, Texas, Alabama, and Florida represent the changes, while Montana, Minnesota, and Michigan show the middle-western trends. Washington and Oregon are somewhat similar, but the two geographical extremes of California and New England have had only small changes.

Let us examine first by months, the maps of change in temperature: Annual temperatures have increased slightly throughout most of the country except in the Southwest and Pacific States; the most significant increases are in the eastern Gulf States; the apparent rise in Nevada may be ignored for reasons to be given later. January reflects the annual trend quite well, but here a larger area in the West shows a downward movement. February temperature changes show a very striking picture: In order to bring out the extent of these changes, figure 5 was drawn with the differences between averages for February shown; only Arizona, California, Oregon, and the western half of Washington had lower temperature averages for 1916–35 than during 1896–1915; 11 out of the 43 States or districts show differences between the means of over three times their standard errors; changes of over twice the standard error occurred in all the States east of the Rocky Mountains, except along the northern and northeastern boundaries; west of the Rockies, the trend tapered off and finally along the Pacific, the changes have been negative; the average increase for the United States for this month, weighted by State areas is 2.49°. March shows no significant trends, but there is a tendency toward increased temperatures in the Middlewest and Lake Region, and a small downward trend in the South.

In April, the entire West and Northwest has been somewhat cooler in the past 20 years than in the preceding period fo the same length. The South, from Texas east, has been warmer. The points for May indicate that there have been only small changes west of the Mississippi, but fairly large average decreases in the East, centered in the Carolinas. Small increases in temperature are shown over most of the country in June with the exception of the Pacific Coast region and the Southwest, including Texas. July is somewhat similar except that the increases here are much larger, and are over twice their standard errors in 10 States of the Middlewest and Rocky Mountain regions; east of the Mississippi they decline, reaching negative values along the entire Atlantic Coast. August is strikingly similar to June. In September the upward trends in the Mississippi Valley are less pronounced than in July and August; an area in the Southwest also shows positive changes in September. This upward trend is continued in October in the Southeast; October in the Central States is colder than previously, and in the South and Southeast is warmer. For November, the map shows the country divided diagonally from Montana to Mississippi; the Rocky Mountain area, especially, has a downward movement of temperature during the period. In December, the northern third of the United States was colder in the past 20 years than in the 20-year period preceding 1916; the greatest upward changes were in the Gulf and South Atlantic States.

The indications of temperature trends shown point out two facts which should be investigated further, probably from a synoptic approach: (1) Different regions of the United States do not show the same secular changes in temperature; (2) these changes are not always even in the same direction in a given locality for different months in

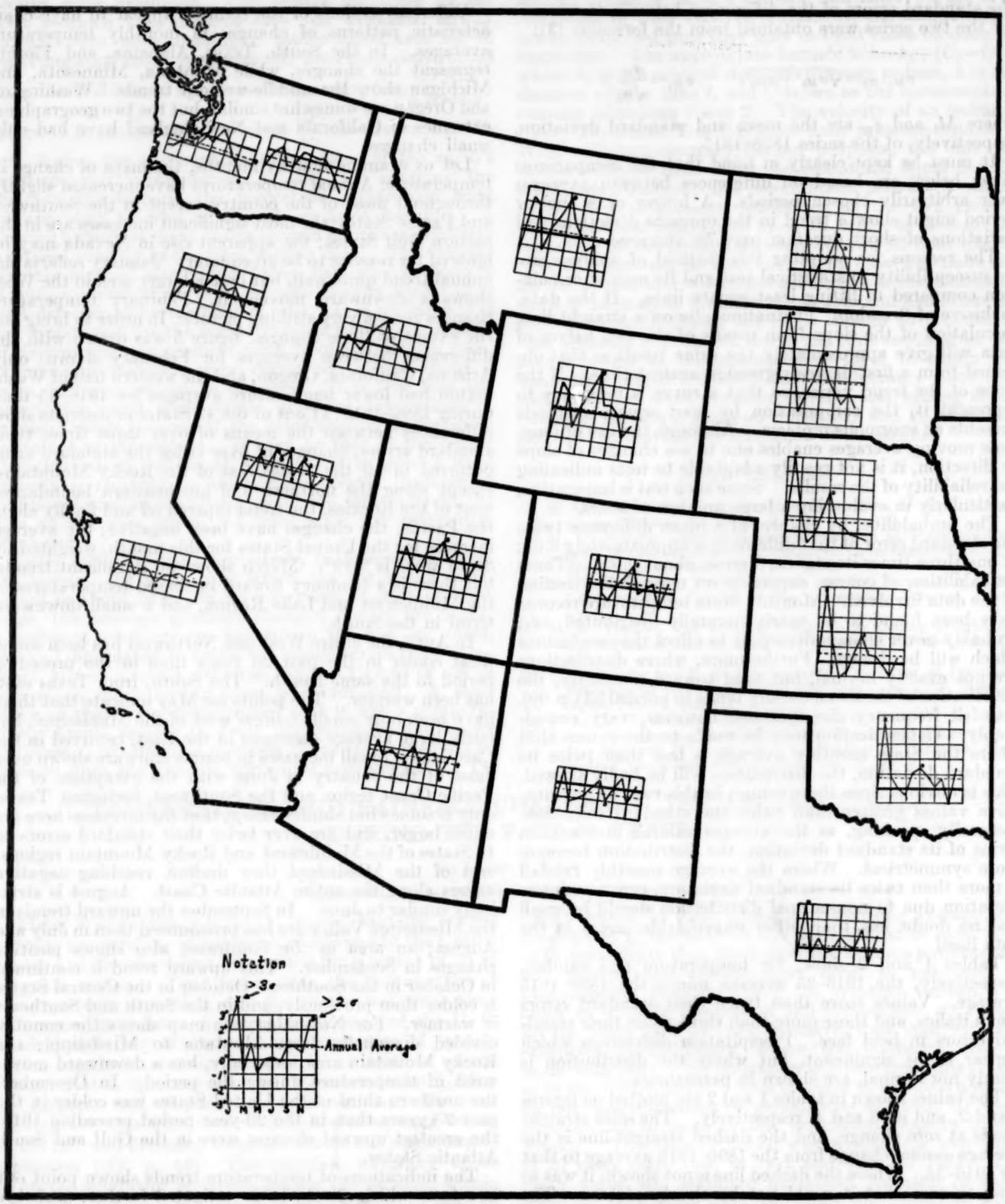


FIGURE 1.—The 1916–35 average of mean monthly State temperatures minus the 1896–1915 average.

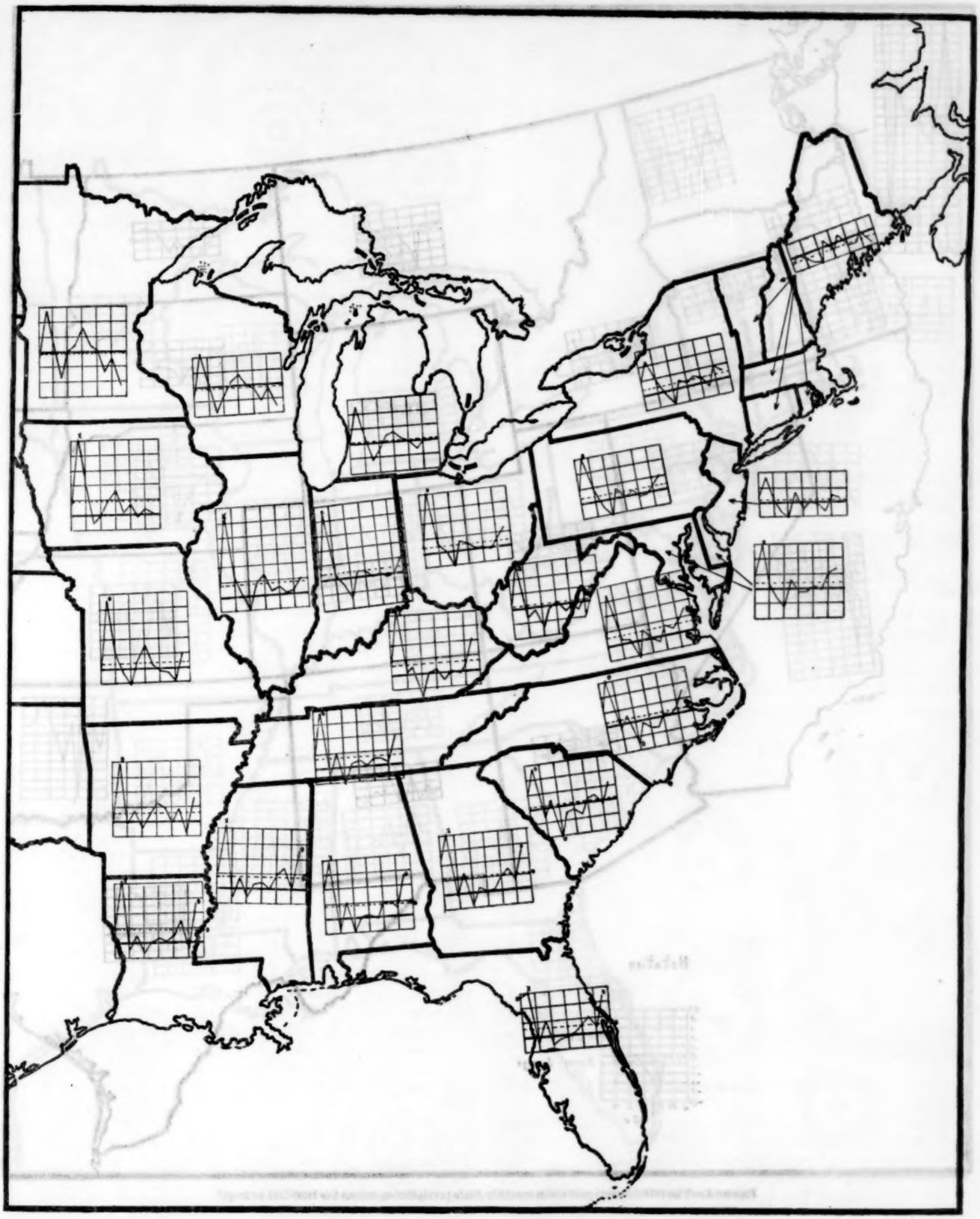


FIGURE 2.—The 1916-35 average of mean monthly State temperatures minus the 1896-1915 average.

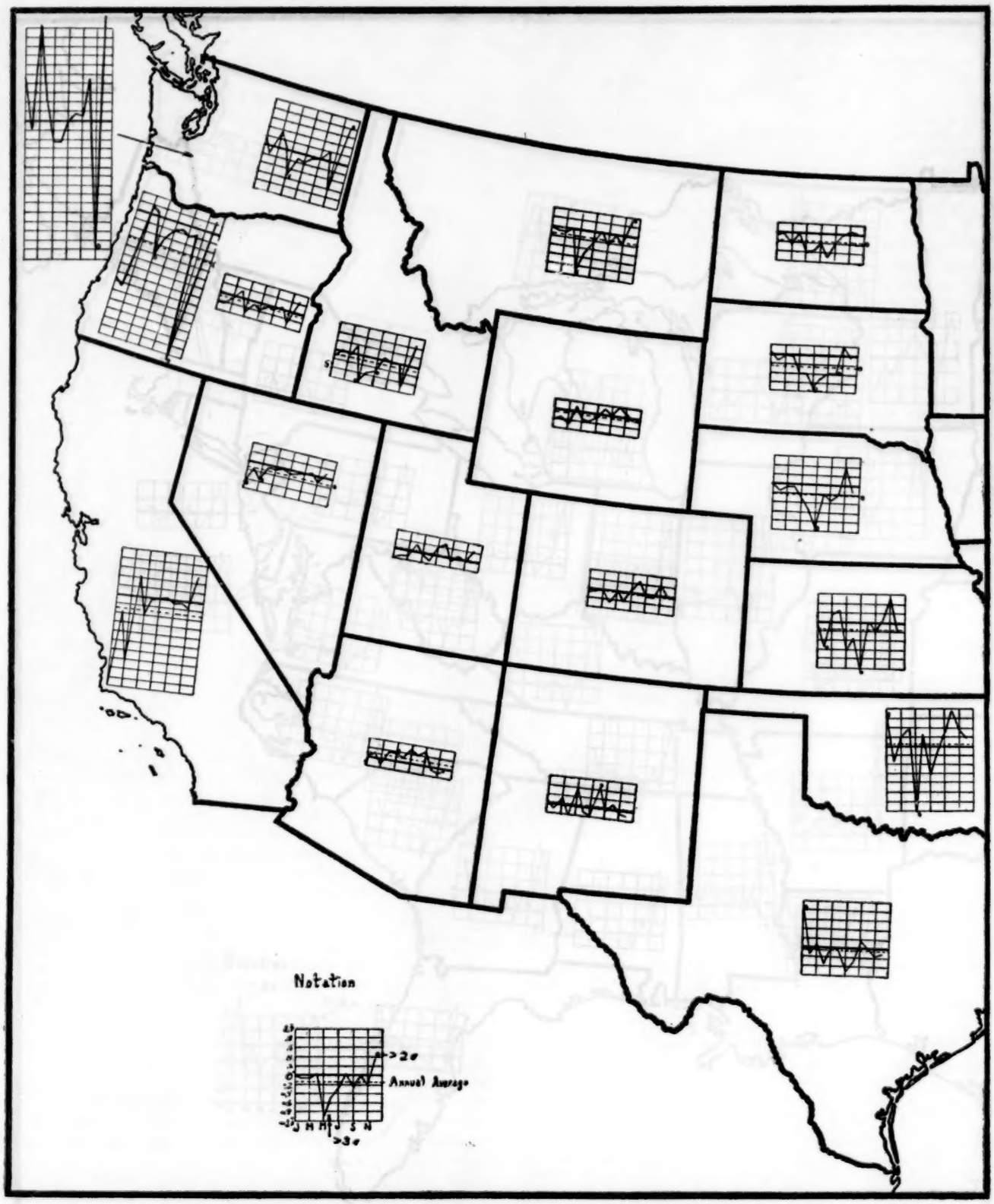


FIGURE 3.—The 1916-35 average of mean monthly State precipitation minus the 1896-1515 average.

FIGURE 4.—The 1916–35 average of mean monthly State precipitation minus the 1896–1915 average.

the same meteorological season. It has been suggested that apparent increases in temperature over long periods are due to artificial factors—the growth of cities, a change in the hours of observation or, where sectional values are used, to a difference in the location of stations. Any explanation on the basis of general changes such as these is in general invalidated when adjoining months have different trends.

What effect do these trends have upon the average annual march of temperature? Figure 7 shows monthly

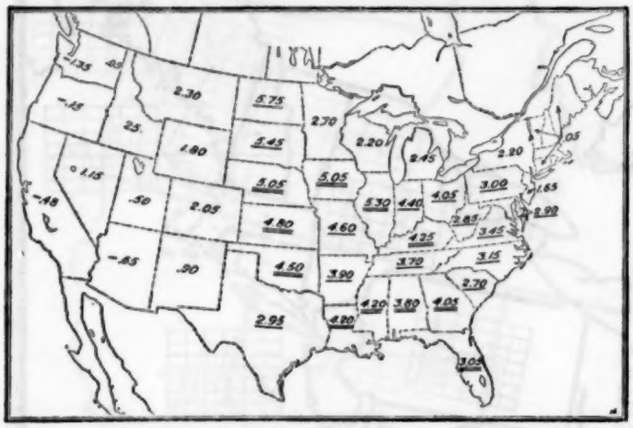


FIGURE 5.—The 1916–35 average of February State temperatures minus the 1896–1915 average. The doubly underlined values are those given in bold face in table 1; the singly underlined, those in italics.

average temperatures for three States, Ohio, Nebraska, and Georgia, for both 20-year periods. In Nebraska and Ohio the shape of the curve is changed somewhat, but in Georgia the averages for the winter months are raised consistently. Since neither of the two sets of averages can be said to represent the normal temperatures, the conclusion may be reached that often so-called normal

FIGURE 6.—The 1916–35 average of annual State precipitation minus the 1896–1915 average. The values shown are 12 times those given in table 2. The doubly underlined values correspond to those given in bold face; the singly underlined, to those in italics.

values are taken too seriously, without due regard to their instability.

As mentioned above, the temperature values for Nevada do not appear to be reliable. In each month, the trend in Nevada has a higher positive or lower negative value than that for the surrounding States. In attempting to find an explanation for this, it was discovered that the average altitude of the stations reporting in 1900 was 5,250 feet; in 1935, it was 4,925 feet, or an average decrease in altitude of 325 feet (about 100 meters). The average surface temperature in mountains decreases approximately at the rate of 1° C. for each 180 meters increase in altitude (4), so this reduction in altitude would account for about 1° F. increase in temperature. An adjustment on this basis would bring the Nevada averages more nearly in line with those of surrounding States. Another factor which may have some influence is the latitude of the station. Several of the later stations are located in the southeastern point of the State, which was represented in the early records by only one station.

The Arizona averages indicate uniformly lower temperatures than 20 to 40 years ago. The average altitude of the stations has changed but little. The five counties of

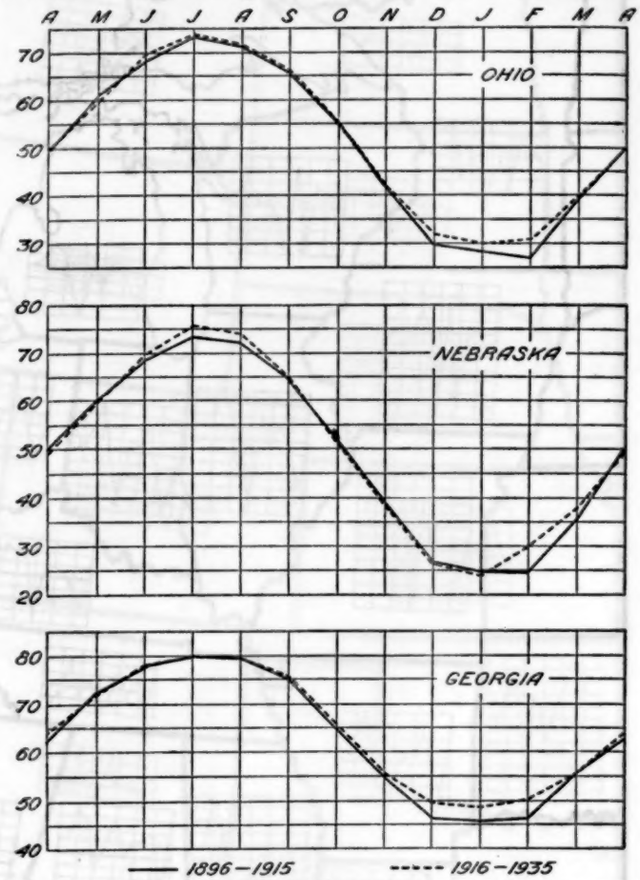


FIGURE 7.—Annual variation of temperature by months for Ohio, Nebraska, and Georgia.

Mojave, Coconino, Yavapai, Navajo, and Apache cover approximately the northern half of the State. In 1897, 26 percent of the stations were in these counties, but in 1935, 40 percent of the observations were in the northern half. This may account for the trend toward lower annual averages, but, of course, has no bearing on the differences between monthly trends.

Turning now to figures 3 and 4, we may investigate the changes in rainfall for the 20 years 1916–35 compared with the next previous period of the same length. Taking the year as a whole (the position of the dotted straight line refers to 1/12th the annual average difference), most of the country has had less rain in the period just passed through with the exception of a few southern states. The North Central States, particularly west of the Mississippi, have been hardest hit, with the possible exception of California and the western half of Oregon. A very interesting feature of this map, which will be mentioned again later, is the increase in rainfall in western Washington in contrast to the large falling off to the south.

In January, the South, from Texas eastward, except Florida, shows increasing rainfall, while western Oregon

and California have decidedly decreased; the change in Oregon is not extremely large compared with its average of 8.40 inches for this month for the 40-year period, but the California average has dropped from 5.84 inches for the period, 1896–1915, to 3.84 inches for 1916–35; looking at the records of individual years, we find four with large precipitation: 1909 with 16.17 inches; 1911, 13.20 inches; 1914, 13.09 inches; 1916, 15.61 inches; the next highest January State rainfall in California was 6.79 inches in 1921. Such wide variations, however, indicate that even the large average difference of 2.00 inches is lacking in statistical significance. This indication is, of course, supported by comparison with the standard error of 1.18. Comparatively small changes are recorded in February for the western half of the United States, but significant reduction in precipitation in Missouri, Illinois, Indiana, and Ohio; the changes shown for these States are quite large compared with their averages for the entire period for this month, of from 2.00 inches in Missouri to 2.58 inches in Ohio. Although milder winters are often associated with heavier precipitation, almost every State has had less precipitation with higher temperatures in the past 20 years in February. The March and April data have nothing of particular note, except perhaps the increase in western Washington and the decrease in California in March.

In May, the Southeast has had increasing rainfall, while that in the west North Central and Northwest has decreased. The June points show a milder decrease in the latter areas together with slight decreases in precipitation in the South. The Missouri, Mississippi, and Ohio Valleys have had less rainfall in July than formerly, significant departures occurring in many States, particularly in the Corn Belt, where July rainfall is an important factor in the production of crops. August and September continue with lowered moisture in Minnesota, the Dakotas, Nebraska, and parts of the South, which is not statistically significant. October rainfall in the Ohio and lower Mississippi valleys has been somewhat more plentiful, but the opposite is true in Minnesota and South Dakota. Apparently the rainy season in Washington and Oregon has been starting later during the past 20 years, since the western portions of both of these states have been much drier in November, but show some increase in December. The Mississippi Valley rainfall has increased in November, especially in the South. December shows the most consistent changes in New England and the Middle Atlantic States, where some significant decreases are indicated.

Returning to the annual figures, which are plotted separately as figure 6, some questions arise. The yearly rainfall along the Pacific coast is determined almost entirely by that during the winter. Why has average precipitation in California and western Oregon decreased while it has increased in Washington? This precipitation is largely due to warm, humid winds from the Pacific. It seems that there has been a secular change in the forces which determine this movement. What is the cause behind this? Is it associated with the distributions of air masses which explain the lack of rainfall in the past few years in the Middle West, or are these more closely related to the increases in precipitation in the South? The answers to these questions would make a good beginning toward an understanding of long-time trends in our weather.

REFERENCES

(1) Kincer, J. B., Monthly Weather Review, 61; 251–259; September 1933.
(2) Hoyt, W. G., and others, Studies of Relations of Rainfall and Run-off in the United States, U. S. Department of the Interior, Water Supply Paper No. 772, 1936.
(3) Fisher, R. A., Statistical Methods for Research Workers, 2d ed., 1928.
(4) Humphreys, W. J., Physics of the Air, 2d ed., p. 40, 1929.

TABLE 1.—*Temperature*

[1916–35 average minus 1896–1915 average]

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Alabama	1.80	3.80	−0.85	1.10	−0.95	0.05	0.20	−0.10	0.95	1.00	0.55	*2.70*	*0.90*
Arizona	*−3.80*	−.65	−1.60	−1.25	−1.60	*−1.60*	−.65	*−1.65*	−1.15	−.90	*−2.40*	−.90	*−1.40*
Arkansas	−.20	*3.90*	−.20	.65	−.45	.45	1.20	.95	−.15	.80	−.85	1.50	.60
California [1]	−1.48	−.48	−.13	−1.04	−.53	−.68	*−1.42*	−.73	−.69	−.43	−.63	.02	−.69
Colorado	−1.55	2.05	−.55	−1.00	.05	.70	*1.80*	−.30	.10	.50	−1.20	.60	.30
Florida	*2.70*	3.05	−.45	.90	−.60	−.30	−.15	.10	.55	1.05	.40	*2.40*	*.60*
Georgia	2.15	4.05	−.15	1.35	−.85	.35	.05	.10	1.00	1.40	.65	*2.65*	*1.05*
Idaho	−2.05	.25	−.15	−.65	.70	1.30	*1.80*	.40	.30	−.10	−1.05	−1.20	.00
Illinois	.70	*5.30*	1.35	.10	−.95	.80	1.35	.25	.50	.05	.25	1.10	.80
Indiana	.20	*4.40*	.30	−.35	−1.40	.40	.40	−.05	.15	−.15	.00	1.05	.40
Iowa	.75	*5.05*	2.05	−.55	−.05	1.00	1.55	.15	.70	−.15	.35	.05	.90
Kansas	−.20	*4.80*	1.35	−1.10	−.70	.60	*1.80*	.50	.45	−.10	−.85	.40	.55
Kentucky	.85	*4.25*	.15	.55	−1.55	.05	.25	−.40	.05	−.05	.40	2.05	.65
Louisiana	1.05	4.20	−.50	.50	−.65	.05	.35	.10	.80	1.50	−.45	*2.60*	*.90*
Maryland and Delaware	.80	*2.50*	.35	−.65	−1.25	.60	−.30	−.25	.15	−.10	1.05	1.35	.40
Michigan	.05	2.45	.55	−1.20	−.50	.45	.70	.20	.00	−.55	−.05	.00	.05
Minnesota	−.75	2.70	.55	−1.65	.05	.45	1.55	.45	.05	−1.35	−.45	−2.25	−.05
Mississippi	1.10	4.20	−.60	.70	−.55	.30	.35	.00	.90	1.35	.00	*2.55*	*.85*
Missouri	.05	*4.60*	.95	−.25	−1.15	.50	1.45	.15	−.20	−.30	−.85	1.00	.35
Montana	−1.45	2.30	1.90	−1.20	.45	1.30	*2.55*	1.10	.35	−.75	−.25	−2.75	.30
Nebraska	−.40	5.05	1.70	−.80	−.25	1.05	*2.70*	.70	.50	−.10	−.25	−.45	.75
Nevada	−.50	1.15	*2.35*	1.40	*2.80*	*2.55*	*3.05*	*1.40*	*2.60*	*2.30*	1.00	1.75	*1.80*
New England	−.65	.05	−.30	−.80	−.95	.45	−.45	.45	−.45	−.50	.15	−.85	−.35
New Jersey	.35	1.65	.25	−.65	−1.05	.65	−.45	.00	−.15	−.65	.50	.30	.15
New Mexico	−2.10	.90	−1.25	−1.05	−.75	−.05	.40	*−.80*	.10	.75	−.95	.30	−.45
New York	1.00	2.20	.55	−.30	−1.00	.50	.35	.60	.45	−.30	1.00	.60	.40
North Carolina	1.15	*3.15*	−.30	.50	*−1.45*	−.10	−.60	−.65	.15	.05	.45	1.50	.30
North Dakota	1.20	*5.75*	3.20	−1.15	.40	.60	*2.35*	*1.55*	.20	−.95	.80	−1.55	1.10
Ohio	.60	*4.05*	.55	.05	−1.05	.70	.45	.10	.10	−.10	.55	1.30	.40
Oklahoma	−.30	4.50	.85	.00	−.40	1.10	*1.40*	.90	.10	.70	−1.00	1.35	.75
Oregon	−1.35	−.15	.35	−.40	.25	1.15	.85	.40	.75	.05	−.60	−.75	−.05
Pennsylvania	.65	*3.00*	.80	−.45	−1.10	.65	.05	.30	−.15	−.10	.50	1.10	.40
South Carolina	1.00	*2.70*	−.65	.50	*−2.10*	−.40	−.30	−.75	.30	.50	−.20	1.20	.15
South Dakota	.55	*5.45*	2.95	−1.25	−.15	.90	*2.90*	1.10	.45	−.55	.25	−.75	.90
Tennessee	.65	*3.70*	−.50	.95	−1.15	.20	.45	.05	.50	.50	.20	1.90	.65
Texas	−.75	*2.95*	−.45	.70	−.25	.00	.85	.30	.10	1.40	−.95	1.15	.25
Utah	−2.45	.50	−.50	−1.15	.35	.55	*1.40*	.10	.75	.65	−1.25	.30	.00
Virginia	1.00	3.45	.30	.20	−1.15	.65	.00	−.35	.70	.35	.80	1.55	.60
Washington:													
Eastern	−1.35	.05	.50	−.75	−.70	.45	.30	.20	.40	−.20	−.80	−1.60	−.45
Western	−1.45	−1.35	−.85	−.80	−.90	−.05	−.35	.70	.10	−.80	−1.30	*−2.10*	*−.75*
West Virginia	.15	*2.85*	−.70	−.25	−1.40	−.15	.20	−.40	−.15	−.45	.40	1.10	.15
Wisconsin	−.55	2.20	.15	−1.75	−.65	.20	.75	.05	−.30	−1.05	−.25	−1.45	−.15
Wyoming	−2.45	1.80	1.15	−1.25	.45	1.45	*2.75*	.60	.65	.05	−1.40	−.65	.10

[1] California record, 1897–1935.

TABLE 2.—*Precipitation*

[1916-35 average minus 1896-1915 average]

	January	February	March	April	May	June	July	August	September	October	November	December	Annual +12
Alabama	0.78	−0.65	0.42	0.28	0.22	−0.06	0.60	0.09	−0.28	0.52	0.71	0.18	0.24
Arizona	.02	.10	−.09	.18	(.18)	.08	.30	.18	.31	−.05	−.10	−.05	.08
Arkansas	.54	−.56	−.00	.51	−.07	.18	−.50	−.51	−.21	.79	.42	.28	.07
California [1]	−2.00	−.36	−1.43	.45	−.39	−.02	.00	.03	−.07	−.06	−.16	.56	−.29
Colorado	−.08	−.04	−.01	−.26	−.02	−.22	.07	.24	−.06	−.06	.22	−.00	−.02
Florida	−.51	−.98	.16	(1.13)	.86	−.08	.10	−.60	.22	.10	.04	−.60	−.02
Georgia	1.84	−.90	−.13	.30	.50	−.34	.68	−.64	.24	−.58	−.00	−.12	−.01
Idaho	−.14	.02	−.01	.18	−.56	−.36	(−.29)	.06	−.02	.00	−.40	.44	−.09
Illinois	−.20	−.76	−.00	.26	−.02	.46	−1.10	.02	.31	.79	.44	.28	.04
Indiana	−.14	−.88	−.36	.45	.10	.20	−.84	−.08	.82	.36	.00	.38	.00
Iowa	−.08	−.27	.06	−.08	−1.35	.42	−1.05	.02	.44	−.18	.62	−.08	−.13
Kansas	−.06	(−.56)	.17	.24	−.62	−.33	−1.06	−.00	−.18	.04	.52	−.20	−.17
Kentucky	.40	−.54	−.13	.11	.20	.10	−.64	.34	.36	.49	.04	−.25	.02
Louisianna	1.48	−.54	.56	−.01	.82	−.46	−.54	−.44	−1.02	.62	1.08	.15	.15
Maryland and Delaware	−.07	−.44	.06	.58	.18	−.24	.11	−.14	.53	−.30	.15	−.66	−.22
Michigan	−.36	−.34	.08	.18	−.36	.21	−.76	−.42	.24	.35	.14	.05	−.09
Minnesota	.10	−.03	−.05	−.14	−.91	−.46	−.82	−.78	−.38	−.72	.20	.06	−.35
Mississippi	.65	−.72	.52	.40	.56	−.40	−.02	−.55	−.78	.80	1.14	.28	.14
Missouri	−.06	−.89	−.04	.28	−.28	.28	−1.42	.26	.12	.55	.76	.18	−.02
Montana	−.02	−.07	−.08	.02	−.88	−.48	−.26	.02	−.23	−.02	−.20	(.34)	−.16
Nebraska	.00	−.14	−.06	−.04	−.30	−.54	−.94	−.20	−.35	−.22	.41	−.14	−.21
Nevada	(−.48)	−.15	(−.34)	−.04	−.06	−.00	−.09	−.04	−.02	.04	−.11	.10	−.12
New England	−.32	−.54	−.61	.28	−.08	.82	−.25	−.20	.40	−.02	.34	−.48	−.06
New Jersey	−.42	−.66	−.50	−.19	−.04	.30	−.03	−.68	.30	−.72	−.02	−.90	−.30
New Mexico	.04	−.09	.14	−.22	.39	−.10	−.18	.46	−.04	.11	−.05	−.11	.03
New York	−.19	−.38	−.32	.34	.03	.44	−.10	−.26	.32	.02	.38	−.44	−.01
North Carolina	.44	−.74	−.26	.26	.02	−.66	.41	−1.00	.54	−.34	.14	−.16	−.09
North Dakota	.00	−.02	−.24	.00	−.42	−.38	−.22	−.51	−.20	−.01	.07	.04	−.16
Ohio	−.16	−.66	−.36	.18	.02	−.03	−.77	.16	.47	.12	.30	−.04	−.06
Oklahoma	(.64)	−.36	.22	.38	−1.42	.26	−.62	−.14	.29	.76	.34	.16	.05
Oregon:													
Western	−1.52	−1.65	.20	.10	−.82	−.40	−.16	−.11	−.21	−.14	−2.92	.24	−.62
Eastern	−.22	−.20	−.05	.15	−.31	−.08	−.17	−.04	−.04	.04	−.27	.22	−.08
Pennsylvania	−.40	−.58	−.58	−.02	.23	.08	−.24	−.26	.18	−.01	.46	−.69	−.15
South Carolina	.46	−.74	−.04	.30	.62	−1.19	.98	−1.34	.72	−.46	−.12	.08	−.06
South Dakota	.04	−.12	−.02	−.04	−.38	−.70	−.51	−.38	−.49	.20	−.04	−.23	
Tennessee	.74	−.18	.38	.04	.54	.00	−.22	.32	.02	.63	.12	−.16	.19
Texas	(.83)	−.12	.08	−.36	.02	−.03	−.50	−.32	.14	.00	−.15	−.12	−.04
Utah	−.20	−.14	−.12	.17	−.03	−.14	.18	.26	−.06	.05	−.00	.22	.02
Virginia	.20	−.37	−.19	.40	.04	−.63	.08	−.24	.20	−.42	.22	−.28	−.08
Washington:													
Eastern	.18	−.18	.36	.09	−.54	−.13	−.18	−.04	.00	.18	−.66	.78	−.01
Western	.96	−.18	2.08	.46	−.47	−.45	−.00	.16	.11	.80	−2.74	2.08	.24
West Virginia	−.12	−.15	.08	.04	.22	−.32	−.40	.66	.38	.39	.32	−.04	.09
Wisconsin	.08	−.03	.04	.14	−.94	.48	−.88	−.40	−.08	−.21	.30	.01	−.13
Wyoming	−.21	−.14	−.26	.12	−.15	−.19	−.06	.14	.02	.20	.08	−.04	−.04

[1] California record 1897–1935.

THE GEOMETRICAL THEORY OF HALOS—III

By EDGAR W. WOOLARD

[Weather Bureau, Washington, D. C., February 1937]

REFLECTION

The calculation of the image produced by external reflection is easily accomplished as indicated in figure 6.[1] Internal reflection (which occurs whenever an internal ray meets an interface at an angle with the normal greater than $\gamma=\arcsin\frac{1}{\mu}$, $\mu>1$) conforms to the same law, but may be associated with refraction at some other point in the complete path of the ray; when the ray is incident

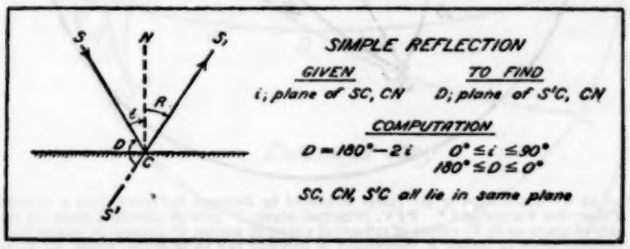


FIGURE 6.—*Simple Reflection:* S, luminous source; SC, incident ray; CN, normal to interface at point of incidence; *i*, angle of incidence; CS_1, reflected ray; R, angle of reflection; S', virtual image; D, deviation.

on, and also emerges from, a face parallel to that from which it is internally reflected, the emergent ray is parallel to the course it would have taken if merely reflected at the point of incidence.

The geometrical relations on a sphere of indefinitely great radius, figure 7, readily lead to appropriate formulae for computation, Formulae II. It is a corollary of the Law of Reflection, that the source and the image lie at equal distances from the geometric pole of every great circle normal to the reflecting plane (any such pole is on the great circle *PP*). Furthermore, the projections of the incident and the reflected rays on any plane through the normal to the reflecting surface make equal angles with the normal, just as if they were actual rays. These principles constitute Bravais' Laws of Reflection. The deviation (angular displacement of the image from the true position of an indefinitely distant source) is away from the normal *N*.

In the case of prismatic refraction accompanied by an internal reflection from a principal plane, figure 8, the projection of the ray on the principal plane is not altered by the reflection; and hence the positions of the images produced with and without such a reflection are symmetric with respect to the principal plane. The calculation of the image, figure 9, is therefore accomplished with Formulae I except that the altitude relative to the principal plane is $-h$ and

$$(6^*)\ \cos D=\cos^2 h(1+\cos D')-1 \qquad (I^*)$$

$$(7^*)\ \sin A=\frac{\cos h \sin D'}{\sin D}$$

by the Law of Cosines and the Law of Sines, respectively. The deviation is toward V and away from P'.

Prismatic refraction accompanied by an internal reflection from any arbitrarily given plane, figure 10, requires the more complicated Formulae III; see figure 11. When the reflecting plane coincides with a principal plane, $\beta=0°$ and the formulae reduce to the previous ones; when the reflecting plane coincides with a lateral face, $\beta=90°$.

Multiple internal reflection will, of course, take place if the once-reflected ray meets the next interface at too great an angle with the normal.

The positions of the images formed by light from the sun or the moon incident on a particular face of an ice crystal of specified form in a given orientation may now be calculated by superposing the appropriate figures on the celestial sphere, with S in the position of the luminary: The preceding formulae give the position of an image relative to the source; and from this, the position relative to the horizon is readily found for any given altitude of the sun or moon, by solving the spherical triangles involved. The formulae required will be given in the next section.

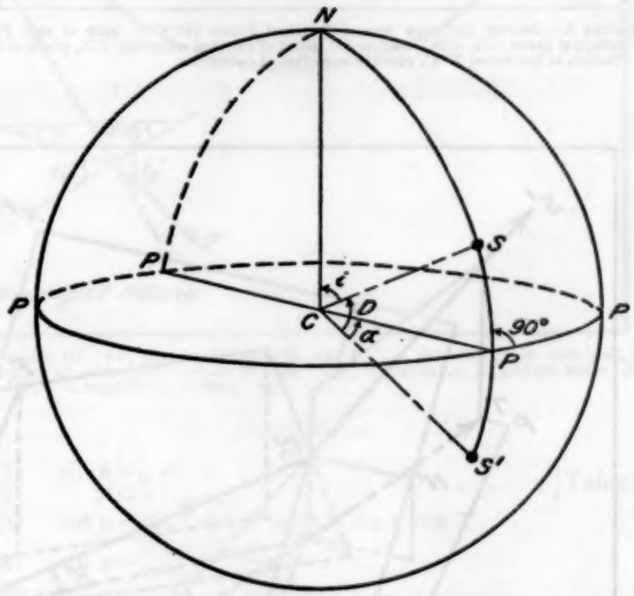


FIGURE 7.—*Calculation of the Image Produced by Simple Reflection:* See Formulae II, PPP, reflecting plane; CN, normal at point of incidence; N, pole of reflecting plane, on same side of plane as source S; S', image; D, deviation; C, observer. The deviation, D, is away from N.

Formulae II

CALCULATION OF IMAGE PRODUCED BY SIMPLE REFLECTION

Given	*To Find*
Angle of incidence, i	Coordinates of S':
Coordinates of S relative to reflecting plane:	Relative to reflecting plane:
Altitude $90°-i$	Altitude a
Relative Azimuth 0°	Relative Azimuth 0°
	Relative to S
	Deviation, D
	Position Angle 180°

Computation

(1) $D=180°-2i$ $\qquad 0°\leq i\leq 90°$

(2) $a=-\frac{D}{2}$ $\qquad -90°\leq a\leq 0°$

[See figure 7.]

[1] The figures are numbered consecutively with those in paper II.

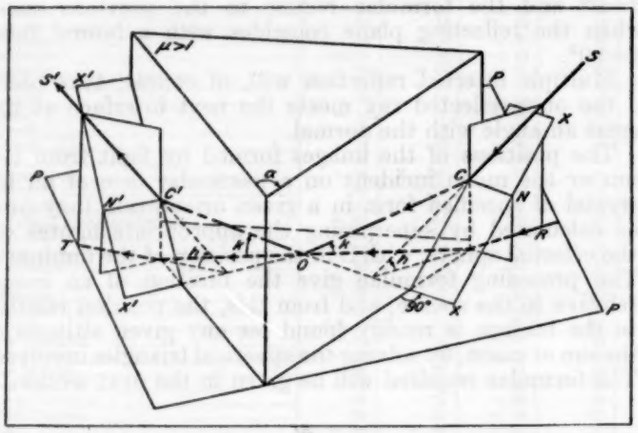


FIGURE 8.—*Internal Reflection from a Principal Plane:* SCOC'S', path of ray; PP, principal plane; CN, C'N', normals; O, point of internal reflection; XX, plane of refraction at incidence; X'X', plane of refraction at emergence.

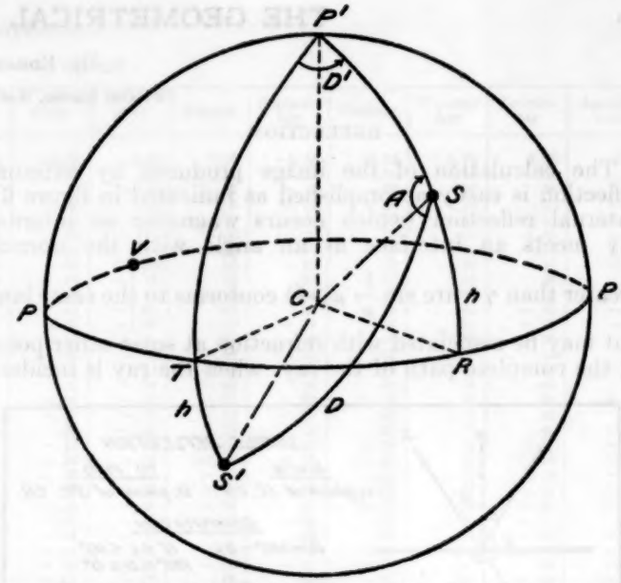


FIGURE 9.—*Calculation of the Image Produced by Internal Reflection from a Principal Plane:* See Formulae I *. PPV, principal plane; P' pole of principal plane on same side of plane as S; V, vertex of refracting angle; S, source; S', image; D, deviation; A, position angle of image; h, inclination of incident ray to principal plane; R, T, projections of source and of image on principal plane; D', deviation of projection of ray on principal plane; C, observer. Deviation is always toward V and away from P'.

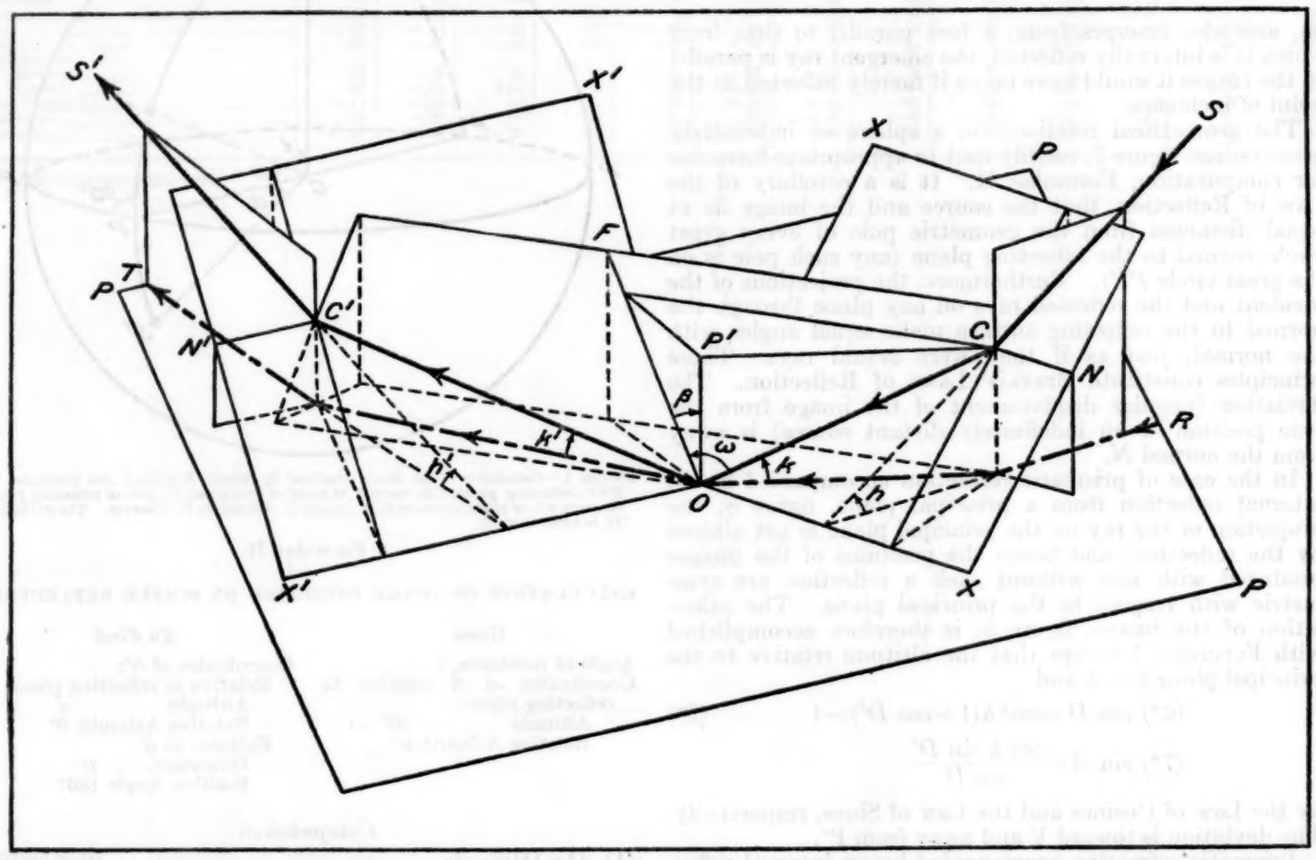


FIGURE 10.—*Prismatic Refraction accompanied by Internal Reflection:* SCOC'S', path of ray; PP, principal plane of refracting angle; OF, normal to reflecting plane; XX, plane of refraction at incidence; FC'OC, plane of incident and reflected rays; X'X', plane of refraction at emergence; CN, C'N', normals to faces of incidence and emergence, respectively.

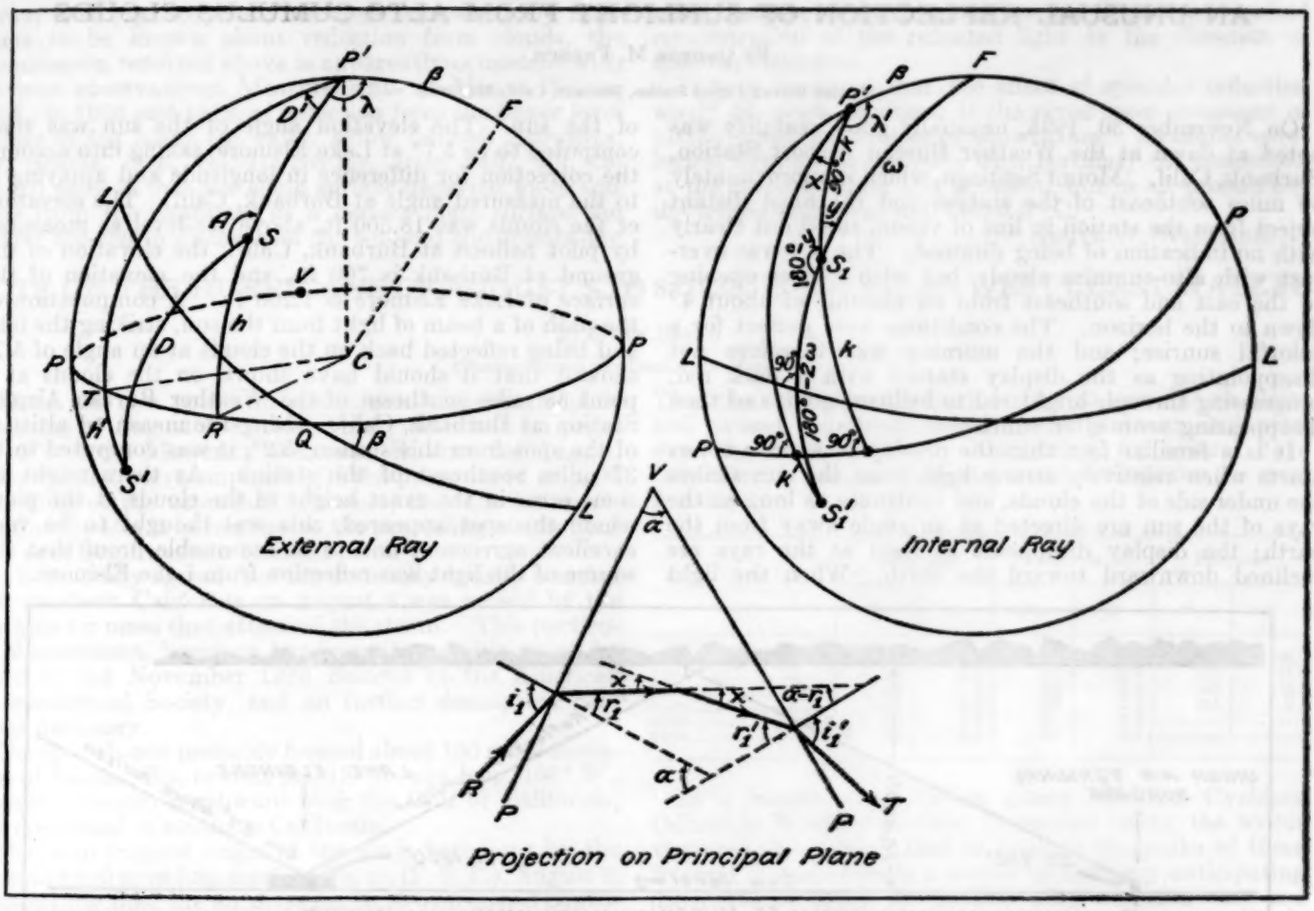


FIGURE 11.—*Calculation of Image Produced by Refraction and Internal Reflection:* See Formulae III. PP, principal plane, with pole P′; LL, reflecting plane, with pole F; S, source; S′, image; R, T, projections of source and image on principal plane; D′ deviation of projection of ray on principal plane; D, deviation; A, position angle. [C, observer at center of sphere is omitted from the diagram; S_1C, S'_1C would correspond to CO, C′O, respectively, in figure 10.]

Formulae III

CALCULATION OF IMAGE PRODUCED BY PRISMATIC REFRACTION COMBINED WITH INTERNAL REFLECTION

Given	*To Find*
μ, α; h; β, λ; i_1	Coordinates of S'
Coordinates of S:	Relative to Principal Plane
Relative to Principal Plane	Altitude $-h'$
Altitude h	Relative Azimuth $\pm D'$
Relative Azimuth 0°	Relative to S
	Deviation D
	Position Angle $\pm A$

Computation

(1) $\sin h = \mu \sin k$
(2) $\lambda' = \lambda + i_1 - r_1$ } Table 3

(3) $\cos \omega = \sin k \cos \beta + \cos k \sin \beta \cos \lambda'$

(4) $\sin y = \dfrac{\sin \beta \sin \lambda'}{\sin \omega}$

(5) $\sin k' = \sin k \cos 2\omega + \cos k \sin 2\omega \cos y$

(6) $\sin h' = \mu \sin k'$

(7) $\sin x = \dfrac{\sin 2\omega \sin y}{\cos k'}$

(8) $r_1' = \alpha + x - r_1$ (Internal reflection occurs if $r_1' > \gamma'$ for h')

(9) $D' = i_1 + i_1' - \alpha$ Table 3 with $h = h'$

(10) $\cos D = \cos h \cos h' \cos D' - \sin h \sin h'$

(11) $\sin A = \dfrac{\cos h' \sin D'}{\sin D}$

[See figure 11. The trigonometrical relations on the sphere follow from the Law of Cosines and the Law of Sines.]

AN UNUSUAL REFLECTION OF SUNLIGHT FROM ALTO-CUMULUS CLOUDS

By GEORGE M. FRENCH

[Weather Bureau Airport Station, Burbank, Calif., May 1936]

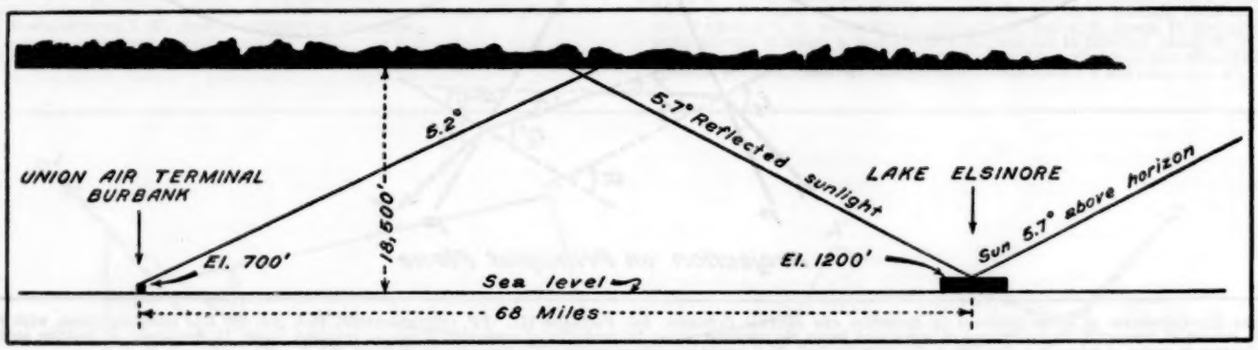
On November 30, 1935, unusually good visibility was noted at dawn at the Weather Bureau Airport Station, Burbank, Calif. Mount Santiago, which is approximately 60 miles southeast of the station and the most distant object from the station in line of vision, stood out clearly with no indication of being dimmed. The sky was overcast with alto-cumulus clouds, but with a clear opening to the east and southeast from an altitude of about 4° down to the horizon. The conditions were perfect for a colorful sunrise; and the morning was therefore not disappointing as the display started with a dark red, progressing through bright red to brilliant gold, and then disappearing soon after sunrise.

It is a familiar fact that the display of sunrise colors starts when relatively strong light from the sun strikes the under side of the clouds, and continues as long as the rays of the sun are directed at an angle away from the earth; the display disappears as soon as the rays are inclined downward toward the earth. When the light which reaches the observer passes over a long path through the earth's atmosphere, it is depleted of the shorter wave lengths by scattering, and the red predominates, slowly changing toward a white light as the sun rises and the rays pass through the atmosphere at a lesser angle with the vertical.

On the morning referred to, as the sun rose it was obscured by the alto-cumulus clouds except as faintly seen occasionally through thin spots in the clouds. However, on this particular morning, after the sun had been obscured by the clouds, the sequence of colors was repeated on one relatively large definite spot; this display was slightly golden in color, and not as brilliant as the preceding. The spot was southeast of the station and a short distance to the right of a direct line toward the sun. It was plainly evident that the phenomenon could not have been produced by light coming through the clouds, but must have been caused by reflected light.

The horizontal position of the sun was noted, and the center of the spot was found to be about 2° to the right of the direction toward the sun. The sun's elevation angle was measured, and the elevation angle of the center of the spot. By means of a pilot balloon the elevation of the base of the clouds was obtained. The cloud layer appeared to have a uniform base except for small undulations.

A map was consulted to find if any rather large bodies of water were in a position to be nearly in line with the sun. It was found that Lake Elsinore, 68 miles southeast of this station, was slightly to the right of the position of the sun. The elevation angle of the sun was then computed to be 5.7° at Lake Elsinore, taking into account the correction for difference in longitude and applying it to the measured angle at Burbank, Calif. The elevation of the clouds was 18,500 ft. above sea-level as measured by pilot balloon at Burbank, Calif.; the elevation of the ground at Burbank is 700 ft., and the elevation of the surface of Lake Elsinore is 1,200 ft. A computation of the path of a beam of light from the sun, striking the lake and being reflected back on the clouds at an angle of 5.7° showed that it should have shown on the clouds at a point 35 miles southeast of the Weather Bureau Airport Station at Burbank, Calif. Using the measured altitude of the spot from this station, 5.2°, it was computed to be 37 miles southeast of the station. As there might be some error in the exact height of the clouds at the point where the spot appeared, this was thought to be very excellent agreement and to be reasonable proof that the source of the light was reflection from Lake Elsinore.



The accompanying figure, in which the scale for elevation is much larger than the one for horizontal distance, illustrates the conditions described.

Wind velocities on the morning of November 30 were generally very light to calm; and although no record was obtainable from Lake Elsinore, it is believed reasonable to assume that it was calm or nearly so, and thus the glassy surface of the lake would give almost a perfect reflecting surface.

Further proof that the source of the light producing the spot was reflection from below is afforded by the fact that the spot receded southeastward as the sun rose, which is as would be expected, since the angle of reflection would decrease as the sun's rays became more nearly vertical.

The phenomenon had never before been noticed by the writer nor by anyone with whom he has discussed the matter; and it is therefore believed that the requisite combination of conditions for its appearance rarely occurs.

NOTE ON THE FOREGOING OBSERVATION

Reflection from clouds is diffuse, and not specular—i. e., a cloud surface illuminated by a directed beam reflects light in all directions. We should therefore expect that the area illuminated by reflection from the lake surface would have been visible from all directions, and not merely at places in the direction of specular reflection.

Near grazing incidence, however, matt surfaces exhibit an effect of regular reflection, especially for long wave lengths, to a surprising extent (*cf.* R. W. Wood, *Physical*

Optics, 3 ed., p. 40); and, although comparatively little seems to be known about reflection from clouds, the phenomenon reported above is apparently consistent with previous observations: Measurements at Mount Wilson, Calif., in 1906 and 1918, of reflection from the upper level surface of fog filling the valley below (*Annals Astrophys. Obs. Smiths. Inst.*, vol. II; *Smiths. Misc. Coll.*, vol. 69, no. 10) showed that the cloud surface departed more and more from the character of a perfect matt surface the greater the zenith distance of the sun and the greater the nadir distance of the cloud; at low sun there was a marked concentration of the reflected light in the direction of specular reflection.

It may be noted that the effect of specular reflection would be much enhanced if the cloud were composed of plate-shaped ice crystals or snow flakes. Available aerological data do not indicate with certainty the conditions at the cloud level on this occasion, but in all probability the temperature was well below 0° C.

EDGAR W. WOOLARD.

NOTE ON THE HURRICANE OF AUGUST 5 TO 8, 1936, IN MEXICAN WEST COAST WATERS

By DEAN BLAKE

[Weather Bureau, San Diego, Calif. March 1937]

There are two points in connection with the tropical hurricane of August 5–8, 1936, briefly described on pages 277–278 of the MONTHLY WEATHER REVIEW for August, 1936, which deserve emphasis: (1) the pronounced tropical properties of the attendant air mass; and (2) the movement of the storm in relation to the prevailing air motions aloft over Southwestern United States.

It is generally agreed that the unusually squally weather over southern California on August 8 was caused by the unstable air mass that attended the storm. This particular phenomenon, however, has been discussed in detail by Ward in the November 1936 *Bulletin* of the American Meteorological Society, and no further description here seems necessary.

The disturbance probably formed about 100 miles southwest of Manzanillo, or near lat. 18° N. and long. 106° W., whence it moved northward over the Gulf of California, and dissipated in southern California.

The deep tropical origin of the air is borne out by the aerographical sounding made at 6 a. m. (P. S. T.), August 8, or about the time the air mass began to overspread Southwestern United States. This sounding showed abnormally high equivalent potential temperatures (Θ_E), and specific humidities (q), especially in the lower levels. Comparisons with the average yearly values for equatorial air over Batavia, (lat. 6° S.), taken from chart V. A., page 90, of Willett's American Air Mass Properties, and with the values for summer over Pensacola, as found on page 65 of the same publication are given below.

During its short life the hurricane took a course northward along the Mexican coast, thence up the Gulf of California, and disappeared from surface maps on the 7th. That the air mass went much farther as unstable air aloft, and caused thunderstorms over the plateaux and even over the northern Rocky Mountains, for several days thereafter, is evidenced by the weather maps for the next few days.

	San Diego		Batavia		Pensacola	
	Θ_s	q	Θ_s	q	Θ_s	q
Surf.	336	15.2	349	17.8	359	20.7
1 km	348	13.0	341	13.2	350	15.6
2 km	345	11.3	336	9.4	345	12.5
3 km	343	10.0	334	7.1	341	9.5
4 km	339	7.7	334	5.3		
5 km	335	5.0	334	3.7		

In a recent paper, West Coast Mexican Cyclones (Monthly Weather Review, December 1935), the writer ventured the opinion that to forecast the paths of these tropical disturbances is a matter of correctly anticipating directions of upper air motions over the area they are likely to traverse. The movement of this hurricane certainly justifies this conclusion.

Winds aloft over southwestern United States during the life of the disturbance were from an easterly or southerly direction—part of the vast upper-level anticyclonic whirl common to this region in the summer—and they corresponded very closely to the direction of travel of the storm. Even after the vortex was no longer discernible at the surface, the remaining unstable air mass was carried northward almost to the Canadian border by this circulation.

NOTES AND REVIEWS

Charles F. Brooks, A. J. Connor, et al. *Climatic Maps of North America*. Published by the Blue Hill Observatory at the Harvard University Press, Cambridge, Mass., 1936.

This publication comprises the maps which are included (on a smaller scale) in the Köppen-Geiger *Handbuch der Klimatologie*, vol. II, part J, The Climates of North America, by R. DeC. Ward, C. F. Brooks, and A. J. Connor. The base maps are of size 43 by 56 cm, the same size as those on which the data were originally plotted. Detailed climatic data for the entire continent of North America, as well as Greenland and the Caribbean region, are presented in this manner for the first time.

The original data for the United States, Mexico, Alaska, and the West Indies were adjusted to 30.44 day (one-twelfth year) "months"; expressed in terms of degrees centigrade and millimeters; and, for six temperature and two pressure maps, reduced to sea level.

Seven elements are represented: temperature, pressure, rainfall, snowfall, humidity, cloudiness, and thunderstorms. Temperature and precipitation maps make up 19 of the 26 maps.

The temperature maps comprise the following: (1) Six sea-level monthly mean temperature maps for alternate months beginning with January; the values were obtained by adding 0.5° C. for every 100 m of altitude above sea-level to the actual normal temperature; by this device distinctive features of temperature distribution are brought out (such as the chinook warmth of Montana as compared to the continental coldness of North Dakota) which are usually masked in ordinary temperature maps. (2) *Actual* mean temperature distributions for January and July. (3) The mean annual range of temperature; this element brings the regions of equable temperature into contrast with those of temperature extremes. (4) The mean values of the annual maximum and the annual

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minimum of actual temperatures; the inclusion of these two maps is believed to be a novel feature.

The precipitation maps comprise: One map depicting the annual rainfall; six maps giving the monthly values for alternate months, beginning with January; the average annual snowfall. This distinction between rainfall and snowfall in maps of mean values of precipitation is also believed to be new.

Sea-level pressure, average cloudiness, and relative humidity are shown for January and July. The humidity data are the mean values of the 8 a. m. and 8 p. m. (E. S. T.) observation values; these mean values are considered to be more representative than either the morning or evening values taken alone, and constitute a third novel presentation.

The final map gives the average annual number of thunderstorm days, which is another map not heretofore available for the whole continent.

A brief text gives important details concerning the numbers and sources of the observations for the various political subdivisions, together with the names of the individuals credited with putting the data in their published form. Differences in the observing practices of the several meteorological services which affect these data are also noted.

The legends at the foot of each map point out the salient features of the maps as well as a few of the significant climatological facts. Prominently displayed on each map, also, are scales giving the English equivalents of the metric values.—*Charles M. Lennahan.*

Recovery of sounding-balloon meteorograph after 23 years.—A record for the interval of time between the release of a sounding balloon and the recovery of the meteorograph was probably established when an instrument which had been sent aloft on July 25, 1913, was found on October 22, 1936, more than 23 years later. The meteorograph was of the Bosch type, and will be placed in a permanent exhibit of meteorological instruments. It was found by Mr. Arthur L. Carey, about 25 miles south of Twenty Nine Palms, Calif., and was 1 of the 23 sent up by the Weather Bureau from Avalon, Calif., between July 23 and August 12, 1913. An account of this series was published in the MONTHLY WEATHER REVIEW, July 1914.

Except for the fact that apparently desert rodents had chewed off one of the pen arms, separated the linkages from the levers of the multiplying mechanisms, and destroyed the humidity element, the meteorograph was in surprisingly good condition; and the tracings on the smoked record sheet were still sufficiently legible to determine some of the principal features of the flight. It was impossible to evaluate the data for all significant points, but those of chief interest were obtained and are given below:

Height of tropopause	11,790 meters, m. s. l.
Maximum height reached	22, 200 meters, m. s. l.
Temperature at tropopause	−56° C.
Temperature at maximum height	−57° C.

L. T. SAMUELS.

BIBLIOGRAPHY

[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Arctowski, Henryk.
Essai concernant l'étude des variations de la pression observées à Paris et ailleurs. Lwów. 1936. 32 p. figs. 23 cm. [At head of title: Institut de géophysique de l'Université de Lwów. Communication No. 110.]

Bailey, Alfred.
Wind pressure on buildings. Edited by H. H. Jeffcott. London. 1933. 29 p. figs., tables. pl. (part fold.) 21½ cm. [At head of title: Institute of civil engineers. Selected engineering papers, no. 139.]

Baldit, M. A.
La perturbation de la température dans le voisinage de la Banne-d'Ordanche (d'après les sondages effectués par avion du 8 au 13 septembre 1935). Paris. 1935. p. [111]–133. figs., tables. 28 cm. [Extrait de "La météorologie" No. 2, Mars–avril 1936 (Troisième série).]

[Bartholomew, John George] 1860–1920.
The Oxford advanced atlas. 5th ed. London, N. Y., etc. 1936. 96, 32 p. incl. col. maps, col. diagrs. 82 cm.

Baur, Franz.
Die Bedeutung der Stratosphäre für die Grosswetterlage. Braunschweig. 1936. p. [237]–247. tables, pls. (col. maps). 30 cm. [Sonderdruck aus der "Meteorologischen Zeitschrift," Heft 7, 1936.]

—— Der Wärmehaushalt der Lufthülle auf der Nordhalbkugel der Erde. Frankfurt a. M. 1936. 6 p. figs. 30 cm. [Sonderdruck aus "Die Umschau," Heft 17, Jahrg. 1936.]

Bergiero, José M.
Climatología agrícola. La lluvia en su aspecto de variabilidad y noción de frecuencia. n. p. [1935.] [4 p.] figs., tabs. 29 cm. (At head of title: Asociación rural del Uruguay.)

Berlage, H. P., jr.
Metingen van de intensiteit van de zonnestraling op verschillende plaatsen in Ned.-Indië in de laatste jaren. Batavia. [1935.] p. [104]–116. figs., tables. 24¼ cm. [At head of title: Overdruk uit het verslag van de 15e vergadering van de Vereeniging van proefstation-personeel te Batavia, October 1935, pagina 104–116.]

Bernheimer, W. E.
Strahlung und Temperatur der Sonne. Berlin. [1936.] p. 333–349. figs. 25 cm. (Sonderab.: Hand. der Astrophys. Bd. VII [1936].)

Bider, M.
Beiträge zur Kenntnis des Jahresganges der Niederschlagsverhältnisse in Basel. Basel. 1935. p. [122]–162. tables, diagrs. 23 cm. (Separatabdruck aus den Verhandlungen der Naturforschenden Gesellschaft in Basel. Band XLVI.)

Birge, Edward Asahel, & Juday, C.
Solar radiation and inland lakes. 4th report. Observations of 1931. (*In* Wisconsin academy of sciences, arts & letters. Trans. Madison, Wisc. 1932. 24 cm. v. 27, p. [523]–562 incl. tabs., diagrs.) Notes from the Limnological laboratory of the Wisconsin geological & natural history survey, no. LI. "Papers cited": p. 561–562.

——— A third report of solar radiation and inland lakes. (*In* Wisc. acad. sciences, arts & letters. Trans. Madison, Wisc. 1931. v. 26, p. [383]–425 incl. illus., tabs., diagrs.) Notes from the Limnological laboratory, etc., no. XLIII. "Literature cited": p. 425.

Böhme, Georg.
Analyse der Schwergewitter vom 9. September 1934 in der Schweiz. (Aus dem Physikalisch-meteorologischen Observatorium Davos.) Braunschweig. 1936. p. 58–63. illus., table. 30 cm. [Sonderdruck aus der "Meteor. Zts.", H. 2, 1936.]

Boerema, J.
De nauwkeurigheid van microklimatologische waarnemingen. Batavia. [1935.] p. [206]–213. illus., tables. 24½ cm. [At head of title: Overdruk uit het verslag van de 15e vergadering van de vereeniging van proefstation-personeel te Batavia, October 1935, pagina 206–213.]

——— Vooruitzichten van een dagelijksche weervoorspelling in Ned.-Indië. Batavia. [1935.] p. [15]–43. figs., tabs. 24½ cm. [At head of title: Overdruk uit het verslag van de 15e vergadering van de vereeniging van proefstation-personeel te Batavia, October 1935, pagina 15–43.]

Bossolasco, M.
Resultati preliminari dei lavori eseguiti dalla Stazione geofisica di Mogadisco durante il Secondo anno polare internazionale 1932–33. Meteorologia ed aerologia. 1935. 11 p. figs., tab. 24½ cm.

British national committee for the polar year, 1932–1933.
Some general characteristics of aurora at Fort Rae, N. W. Canada, 1932–1933. Edinburgh. 1935. 6 p. 25 cm. [At head of title: International polar year, 1932–1933. British expedition to Fort Rae.]

Brooks, Charles Franklin.
The possibilities of long-range seasonal forecasts based on ocean temperatures. [n. p.] 13 p. 23½ cm. [Reprint from "The semicentenary celebration of the founding of the University of California. 1868–1918."]

Conrad, V.
Gutachten über die Sonnenscheinverhältnisse von Bad Ischl. Wien. 1933. 7 p. 22½ cm. [At head of title: Sonderabdruck aus Heft 7, Jahrgang 1933, der Mitteilungen des Volksgesundheitsamtes.]

——— Physikalische Grundlagen der Klimatologie. [Leipzig.] n. d. 43 p. tabs., diagrs. 24½ cm. [At head of title: Sonderabdruck aus Tuberkulose-Bibliothek, Nr. 46.]

Cornell University. Ithaca, N. Y.
Earth forms: Earth forms of interest to little children. Ithaca. 1931. 36 p. illus., diagr. 23 cm. (Cornell rural school leaflet. v. 24, no. 3, Jan. 1931.)

Courant, Richard.
Differential and integral calculus. Translated by E. [J.] McShane. London & Glasgow. 1934–1936. 2 v. (*Translation of* Vorlesungen über Differential–und Integralrechnung.)

Dike, P. H.
The effect of atmospheric humidity on unsealed resistors, causes and remedy. Philadelphia. 1936. 12 p. figs., tabs. 27 cm. [Reprinted from The review of scientific instruments, July 1936.]

Douglas and Clydesdale, Douglas Douglas-Hamilton, marquis of, & M'Intyre, D. F.
The pilots' book of Everest. Preface by Lt.-Col. the Rt. Hon. the Lord Tweedsmuir. Garden City, N. Y. 1936. xvi, 270 p. illus. (incl. maps), plates (part fold.), 2 ports. (incl. front.) 22 cm. Maps on lining-papers. "First edition."

Eklund, Ernest E.
Report on a meteorological survey of proposed sites for the San Francisco municipal airport. [Wash.] 1928. 69p. illus., tabs. (part fold.), map. 28 cm. (Typewritten.)

Fink, Otto.
Zur Thermodynamik strenger und milder Winter. Würzburg-Aumühle. 1936. 62 p. tabs., diagrs. 22½ cm.

Gage, Simon Henry.
The microscope. 16th ed., rev. & enl. by the addition of a chapter on micro-incineration. Ithaca, N. Y. 1936. vii, 617 p. illus., diagrs. 23½ cm.

Gillette, Halbert P.
Compound weather and climatic cycles. [n. p.] 1935. [2 p.] 28 cm. [Reprinted from the January 1937 issue of Water works and sewerage.]

Humphreys, William Jackson.
Some episodes along the meteorological highway. Wash., D. C. 1936. p. [435]–452. ports., maps. 25½ cm. [Reprinted from Journal of the Washington academy of sciences, v. 26, no. 11, Nov. 15, 1936.]

Huxley, Julian Sorell, & Andrade, E. N. da C.
More simple science: earth and man . . . with drawings by L. R. Brightwell and Comerford Watson. New York & London. [°1936]. 352 p. illus., diagrs. 20½ cm. Chap. 1. "Earth and its climates." p. 1–63. Chap. IV. "Soil." p. 154–195.

Jaumotte, J.
La diffusion des gaz dans le champ de la pesanteur et l'ozone atmosphérique. Bruxelles. 1936. 27 p. figs., tables. 24½ cm. Bibliographie: p. 27. [At head of title: Institut royal météorologique de Belgique. Mémoires, vol. VI.]

Jensen, Chr.
Die gegenwärtigen Probleme und Aufgaben welche mit dem Studium der atmosphärischen Polarisation verknüpft sind. Kiel. 1908. p. 166–175. tab., diagrs. 29 cm. [Vortrag gehalten auf der Versammlung der Deutschen meteorologischen Gesellschaft in Hamburg, Sept. 1908.]

——— Über die grosse atmosphärisch-optische Störung von 1912. Berlin. 1912. 12 p. tabs. 24½ cm. [Separatabdruck aus den Mitteilungen der Vereinigung von Freunden der Astronomie und kosmischen Physik.]

Lugeon, Jean.
Les travaux de météorologie agricole de l'Institut national météorologique de Pologne. Warsaw. 1935. 31 p. tabs., diagr., maps (1 fold.)

Metropolitan life insurance company.
Deaths from heat and sunstroke in the United States. New York. 1936. 11 p. tabs., diagr. 23½ cm. [At head of title: Statistical bulletin. v. 17, no. 7, July 1936.]

Milch, W.
Optik der Atmosphäre. Leipzig. 1928. p. [213]–253. tabs. 24½ cm. [Sonderdruck aus Handbuch der Experimentalphysik, Bd. 25, Teil 1.]

Moyer, James Ambrose, & Fittz, Raymond U.
Air conditioning. 1st ed. New York & London. 1933. vii, 390 p. illus., diagrs. (part fold.) 23½ cm. "Tables": p. 376–384.

SOLAR OBSERVATIONS

THE COMPUTATION OF β AND w FROM SOLAR RADIATION INTENSITY MEASUREMENTS

By HERBERT H. KIMBALL, Research Assistant, Harvard University

In the MONTHLY WEATHER REVIEW for January 1937, page 18, reference is made to a previous intention that, beginning with January 1937, the Ångström-Hoelper-Feussner curves for the determination of β and w should replace the curves that had been computed by myself and had heretofore been used in the United States. Attention was drawn to the fact, however, that in almost the first attempt to use the new curves for computing β and w from intensity measurements obtained at the Blue Hill Observatory, the difference $I_m - I_r$ fell above the curved line representing $\beta=0$, while from my own curves a definite value of β was consistently obtained. The same circumstance occurred several times during January and February of the present year. Since a value of β less than zero can have no meaning, it is necessary to continue the use of my curves until the above discrepancy is explained.

Apparently, the difference in the two sets of curves arises from a higher value of I_m given by my computations when $\beta=0$; the difference from the European curves appears insignificant when $m=0$, but increases as m increases. The American curves (MONTHLY WEATHER REVIEW, 1933, pp. 82 and 83, figures 2, 3, and 4) were computed from Ångström's well known equations; but for $\beta=0$, data and equations originally developed by Lord Rayleigh and later modified by King, were employed. See *Smithsonian Meteorological Tables*, 5th revised edition, 1931, p. lxxxiii, and table iii, p. 240.

The following example will illustrate the reduction of pyrheliometric observations for the computation of β and w: The first line in the accompanying table gives the observed values at Blue Hill on February 27, 1937. In the second line these values have been reduced to mean solar distance. In the third line: I_m has been divided by 1.940 and is, therefore, represented as a percentage of the solar constant (71.1 percent); I_r and I_r have been further reduced by dividing them by the transmissions of the respective screens for a temperature three degrees higher than the air temperature at the time the measurements were made (table 4, MONTHLY WEATHER REVIEW, January 1936, p. 5).

I have preferred to determine the water vapor content of the atmosphere from the amount of depletion it produces in the intensity of the radiation in the entire spectrum. On the day under consideration, February 27, 1937, β, computed from $I_m - I_r$, is 0.015, and computed from $I_y - I_r$ is 0.033, giving a mean value of 0.024. With this value of β the value of I_m(dry) is 0.800, as compared with 0.711 determined from I_m reduced to mean solar distance and divided by 1.94; the difference, 0.800−0.711 =0.089, represents the absorption of solar radiation in passing over a path $m=1.900$.

The length of the path over which the solar rays pass before reaching the place of observation is a factor in determining the depletion. In plotting the sums of the absorption in individual bands as determined by Fowle, it was found that on an average this depletion (the absorption when $m=1$) was represented by the total measured absorption divided by $m^{1/2}$; i. e., in the case under consideration, the depletion for $m=1.900$ is given by 0.089/1.38=0.064, or 6.4 percent of the solar constant. This is principally absorbed by water vapor, but 0.2 percent to 0.4 percent is attributed by Fowle to absorption by ozone, leaving 6.0 percent to absorption by water vapor.

An equation on page lxxxiii, *Smithsonian Meteorological Tables*, 5th revised edition, 1931, which is there attributed to Fowle, is repudiated by him. He casually mentioned it in the MONTHLY WEATHER REVIEW, Vol. 42, pp. 2–4, 1914, as an approximation formula that might be used when a better method was not available; but Hann appears to have been the originator of this equation (see *Smithsonian Meteorological Tables*, p. lxxii), which served a useful purpose in earlier days before elaborate studies of the great water vapor absorption bands in the infra-red section of the solar spectrum by modern spectroscopic methods were available.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	β_{m-r}	β_{y-r}	β_{m-y}	$\frac{I_{m-r}}{1.94}$	$\frac{I_{m-r}-I_m}{1.94}$	w
1937											
February 27:	° ′	m	gr. cal.	gr. cal.	gr. cal.						mm
(1) 2:14 p. m.	30 55	1.94	1.405	0.933	0.756						
(2)			1.380	.916	.742						
(3)			0.711	1.083	.878	0.015	0.033	0.024	80.0	8.9	6.4

SOLAR RADIATION MEASUREMENTS DURING FEBRUARY 1937

By CHARLES M. LENNAHAN

For a description of the instruments and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged below normal for the morning observations at Washington. The average intensities were above normal for Blue Hill and for the afternoon observations at Washington. Madison and Lincoln intensities are scattered about the normal values, with no definite positive or negative tendencies.

Table 2 shows that the values of the total solar (direct and diffuse) radiation received on a horizontal surface were below normal at half (7) of the stations for which normals are used, and were above normal at the others.

The turbidity values for Washington, as shown in table 3, are relatively low. It should also be noted that the variation in water-vapor is very slight.

No polarization observations were made during February because of the presence of a snow cover on the days which were otherwise favorable for such observations.

TABLE 1.—*Solar radiation intensities during February 1937*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance: 7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	87.7°	Noon
	Air mass: 75th mer. time	A. M.				*1.0	P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Feb. 2	1.78	0.43	0.67	0.96	1.13	------	1.15	------	------	------	1.45
Feb. 3	1.68	.70	.88	1.08	1.38	------	1.29	1.12	1.00	0.83	1.52
Feb. 6	2.36	.41	.52	.76	.97	------	------	------	------	------	2.87
Feb. 10	3.00	.48	.56	.76	1.08	------	------	------	------	------	2.49
Feb. 11	1.37	.49	.64	.86	1.27	------	1.25	1.10	.90	.84	1.24
Feb. 12	2.74	------	------	.90	1.18	------	------	------	------	------	2.74
Feb. 14	8.18	------	------	------	------	------	1.24	.79	------	------	2.49
Feb. 15	3.81	.72	.86	.98	1.29	------	------	------	------	------	3.30
Feb. 17	1.88	------	1.16	1.30	1.52	------	1.39	1.21	------	------	2.26
Means	------	.54	.76	.92	1.19	------	1.26	1.06	(.95)	(.84)	------
Departures	------	−.17	−.07	−.09	−.01	------	+.65	+.06	+.09	+.07	------

TABLE 1.—*Solar radiation intensities during February 1937*—Con.

MADISON, WIS.

Date	Sun's zenith distance: 7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	87.7°	Noon
	Air mass: 75th mer. time	A. M.				*1.0	P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	al.	al.	cal.	mm.
Feb. 2	0.53	0.98	1.10	------	------	------	------	------	------	------	1.37
Feb. 6	1.68	1.08	1.14	1.32	------	------	------	------	------	------	1.02
Feb. 9	.66	.79	.76	1.29	1.40	------	------	------	------	------	1.07
Feb. 10	.51	.60	1.00	1.18	1.38	------	------	------	------	------	.79
Feb. 16	2.16	.85	.94	1.14	1.54	------	1.54	------	------	------	2.06
Feb. 18	3.81	.82	1.00	1.17	1.38	------	1.30	------	------	------	3.63
Feb. 23	1.37	.85	1.00	1.11	------	------	------	------	------	------	1.45
Feb. 25	1.24	------	------	------	1.35	------	------	------	------	------	1.96
Means	------	.85	.99	1.20	1.41	------	(1.42)	------	------	------	------
Departures	------	−.07	−.07	.00	+.05	------	−.03	------	------	------	------

LINCOLN, NEBR.

Feb. 2	1.45	1.07	1.23	1.35	1.50	------	1.48	1.32	1.16	1.01	1.45
Feb. 4	.81	------	------	------	1.47	------	1.46	------	------	------	1.12
Feb. 9	.91	------	------	------	------	------	1.49	1.30	1.13	1.05	.96
Feb. 10	1.07	------	1.07	1.26	1.44	------	1.31	1.15	.95	------	2.62
Feb. 13	4.37	------	------	1.33	1.45	------	------	------	------	------	2.74
Feb. 16	2.06	1.01	1.14	1.29	1.47	------	1.46	1.12	------	------	2.74
Feb. 18	2.87	------	------	.78	.21	------	------	.10	.30	------	3.45
Feb. 23	2.62	------	------	------	------	------	1.44	------	------	------	1.60
Feb. 24	1.68	------	1.28	------	------	------	------	------	------	------	1.85
Feb. 25	1.12	.90	1.03	1.16	1.39	------	------	------	------	------	1.37
Means	------	.99	1.15	1.08	1.30	------	1.44	1.00	.82	(1.03)	------
Departures	------	+.06	+.13	+.03	−.07	------	+.08	−.15	−.19	+.11	------

BLUE HILL, MASS.

Feb. 1	3.5	------	------	------	1.38	------	1.38	1.10	------	------	2.5
Feb. 2	2.0	------	------	------	1.20	------	------	------	------	------	1.0
Feb. 3	1.5	------	------	------	1.23	------	1.35	1.25	1.15	1.05	1.7
Feb. 4	1.5	1.12	1.18	1.25	1.32	------	1.35	1.25	------	------	1.7
Feb. 7	2.1	------	------	1.00	1.30	------	1.30	1.23	------	------	1.6
Feb. 10	3.3	------	------	------	------	------	1.34	1.23	1.13	------	3.2
Feb. 11	2.0	------	------	------	1.28	------	1.43	1.33	1.19	1.08	1.2
Feb. 12	2.1	------	------	------	------	------	1.13	1.10	.85	------	2.4
Feb. 16	2.5	------	------	1.20	------	------	------	------	------	------	2.6
Feb. 17	1.4	------	------	------	------	------	1.37	1.26	1.15	1.06	.6
Feb. 19	2.9	------	.84	1.10	1.27	------	1.14	1.07	1.02	.96	1.9
Feb. 23	2.3	------	------	1.05	1.10	------	1.10	.97	.86	.79	2.0
Feb. 24	3.0	------	------	------	------	------	1.03	------	------	------	3.5
Feb. 26	2.8	------	------	------	------	------	1.03	------	------	------	2.0
Feb. 27	2.1	------	------	------	1.40	------	1.40	1.30	1.21	1.13	1.2
Feb. 28	1.3	------	------	1.24	1.36	------	1.40	1.31	1.20	1.14	1.5
Means	------	(1.12)	(1.01)	1.16	1.28	------	1.27	1.20	1.08	1.03	------
Departures	------	+.24	+.02	+.09	+.02	------	+.01	+.04	+.01	+.02	------

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	196	192	234	133	211	238	49	193	340	283	185	290	237	466	118	115
Feb. 5	169	216	268	176	182	245	36	231	270	342	290	260	180	436	102	140
Feb. 12	215	239	255	172	193	247	70	266	216	335	295	272	210	448	169	176
Feb. 19	174	231	281	180	185	371	90	287	356	333	274	373	216	415	166	208
	Departures from weekly normals															
Jan. 29	−7	+4	+10	+13	+37	+37	+6	−9	.....	−60	−24	+30	+8	.....	+16	−63
Feb. 5	−42	+9	+5	+45	+20	−44	−18	+13	.....	−5	+74	−18	−64	.....	−12	−45
Feb. 12	−7	+23	−17	+29	+23	−45	−2	−18	.....	−12	+54	−20	−49	.....	+40	−12
Feb. 19	−83	−13	−16	−3	−14	+32	−27	+33	.....	−36	+13	+51	−66	.....	+39	+1
	Accumulated departures on Feb. 25, 1937															
	−3,339	−294	+294	+406	+147	+1,148	−189	−273	.....	−938	+399	−441	−2,324	.....	+777	−1,617

ON THE METHOD EMPLOYED FOR COMPUTING β AND W, SEE P. 430 OF THE DECEMBER 1936 REVIEW.—ED.

TABLE 3.—*Total, I_m, and screened, I_v, I_r, solar radiation intensity measurements, obtained during February 1937 and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

[American University, Washington, D. C.]

Date and hour angle	Solar altitude	Air mass	I_m	I_v	I_r	(*) $\frac{I_v}{.851+C}$	(*) $\frac{I_r}{.840+C}$	(*) $\beta_{I_{v-r}}$	(*) $\frac{I_{w=0}}{1.94}$ Percentage of solar constant	(*) $\frac{I_{w=0}-I_m}{1.94}$ Percentage of solar constant	w	Air mass type
Feb. 2:	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*				*mm*	
1:07 p. m	32 08	1.88	1.326	1.074	0.872	1.220	1.002	0.021	81.4	13.3	10.9	Pc.
1:04 p. m	32 26	1.87	1.366	1.075	.873	1.221	1.003	.021	81.4	14.8	11.5	
Feb. 11:												
2:27 a. m	26 45	2.22	1.222	.962	.782	1.097	.902	.036	75.2	14.1	11.4	Pc.
2:21 a. m	27 32	2.16	1.251	.965	.782	1.100	.902	.034	75.5	13.0	11.1	
Feb. 17:												
0:49 p. m	37 44	1.63	1.498	1.069	.849	1.190	.958	.014	84.5	10.5	10.5	Pc.
0:53 p. m	37 56	1.62	1.477	1.068	.848	1.191	.957	.014	84.5	11.3	10.9	

*Values reduced to mean solar distance.

TABLE 3.—*Total, I_m, and screened, I_v, I_r, solar radiation intensity measurements, obtained during February, 1937, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated. Blue Hill Meteorological Observatory of Harvard University.*

Date and hour angle	Solar altitude	Air mass	I_m	I_v	I_r	(*) $\frac{I_v}{0.851+C}$	(*) $\frac{I_r}{0.840+C}$	(*) β mean	(*) $\frac{I_{w=0}}{1.94}$ Percentage of solar constant	(*) $\frac{I_{w=0}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
1937												
Feb. 1:	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*				*mm.*	
1:07 a. m	31 17	1.92	1.231	0.806	0.711	0.916	0.818	0.060	73.1	11.5	8.4	Pc
Feb. 2:												
1:00 a. m	30 12	1.98	1.072	.695	.611	.788	700	.078	69.0	15.3	11.0	Pc
Feb. 3:												
1:08 a. m	31 41	1.90	1.334	.834	.693	.946	.796	.088	66.8	5.0	3.7	Pc
1:05 p. m	29 49	2.01	1.350	.834	.703	.947	.809	.055	73.0	5.4	3.9	
Feb. 4:												
3:48 a. m	11 41	4.83	1.190	.764	.642	.867	.735	.....	.....	.....	.....	Pc
0:20 p. m	31 24	1.92	1.318	.796	.693	.856	.796	.062	72.4	6.4	4.7	
Feb. 7:												
1:42 a. m	27 45	2.14	1.251	.810	.675	.922	.777	.072	73.6	10.9	7.5	Pc
Feb. 10:												
1:35 p. m	29 36	1.81	1.302	.873	.712	.903	.820	.049	71.3	2.9	2.2	Pc
3:10 p. m	18 01	3.21	1.219	.822	.667	.937	.769	.023	71.1	9.9	5.5	
Feb. 11:												
1:02 a. m	32 00	1.88	1.290	.850	.....	.968	.....	.....	.....	.....	.....	
0:58 p. m	32 12	1.87	1.449	.941	.772	1.072	.889	.041	77.1	4.4	3.2	Pc
3:22 p. m	17 38	3.28	1.302	.889	.730	1.013	.890	.009	77.9	12.5	7.0	
Feb. 12:												
0:52 p. m	33 49	1.79	1.131	.762	.615	.868	.711	.082	67.4	10.6	8.0	Pc→NPc
4:02 p. m	14 41	3.89	.873	.611	.500	.697	.578	.049	49.8	6.0	3.1	
Feb. 16:												
3:08 a. m	20 29	2.84	.885	.653	.546	.744	.631	.106	56.0	11.5	6.5	Pc
Feb. 17:												
2:55 p. m	29 38	2.02	1.370	.889	.723	1.028	.836	.030	78.4	9.6	6.8	Pc
4:08 p. m	11 34	4.87	1.072	.738	.611	.842	.704	.....	.....	.....	.....	

*Corrected for transmission of screens and reduced to mean solar distance.

TABLE 3.—*Total I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February, 1937, and determinations of the atmospheric turbity factor, β, and water-vapor content, w—depth in millimeters, if precipitated. Blue Hill Meteorological Observatory of Harvard University*—Continued.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	(*) $\frac{I_y}{0.851+C}$	(*) $\frac{I_r}{0.840+C}$	(*) β mean	(*) $\frac{I_{w=0}}{1.94}$ Percentage of solar constant	(*) $\frac{I_{w=0}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
1937	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*				*mm.*	
Feb. 19:												
3:13 a. m.	20 54	2.78	1.084	.740	.623	.846	.721	.049	69.2	14.6	8.5	NP
0:00 m.	36 31	1.61	1.314	.774	.667	.885	.763	.086	68.4	2.2	1.8	
1:45 p. m.	35 33	1.72	1.159	.766	.631	.873	.786	.059	69.0	10.6	8.2	
4:04 p. m.	12 47	4.44	.842	.595	.498	.683	.572	.056	54.6	12.2	9.2	
Feb. 23:												
1:36 a. m.	33 26	1.81	1.286	.844	.701	.967	.812	.076	69.8	11.6	8.7	NPC
2:06 p. m.	30 32	1.96	1.215	.786	.655	.897	.761	.096	65.7	4.4	3.2	
4:15 p. m.	12 02	4.78	.881	.635	.518	.729	.600	.042				
Feb. 25:												
0:02 a. m.	39 41	1.60	1.032	.703	.586	.807	.679	.169	59.2	7.0	5.6	NPC
Feb. 26:												
1:27 p. m.	34 12	1.78	1.060	.730	.600	.876	.699	.137	62.3	8.7	6.6	PA
Feb. 27:												
0:05 a. m.	39 26	1.57	1.437	.953	.754	1.095	.876	.026	79.8	7.1	5.7	PC
2:14 p. m.	30 55	1.94	1.405	.933	.756	1.083	.878	.024	80.2	9.1	6.6	
4:34 p. m.	10 54	5.16	1.131	.794	.651	.912	.755					
Feb. 28:												
1:54 a. m.	33 26	1.81	1.382	.891	.730	.987	.846	.084	71.0	1.1	0.8	PC
0:25 a. m.	39 34	1.57	1.429	.921	.762	1.044	.883	.042	80.6	7.4	6.0	
2:01 p. m.	32 43	1.85	1.251	.832	.677	.953	.786	.062	72.9	10.6	7.9	

*Corrected for transmission of screens and reduced to mean solar distance.

Atmospheric conditions during solar observations February 1937

Date	Time from local noon	Temperature °C.	Wind, Beaufort	Sky blue	Visibility	Cloudiness and remarks
Feb. 3	1:38 a. m.	−6.4	NW 4	8	9	Few Cu; light haze.
3[1]	1:31 a. m.	−5.2	NW 4	8	9	Few Cu; light haze; instrument indoors.
3	0:22 p. m.	−1.7	NW 2	8	9	Zero clouds; light haze.
4	3:21 a. m.	−10.5	NW 2	9	9	Few Acu; light haze.
7	2:16 a. m.	−2.8	W 4	8	8	Few Ci; few Frcu; light haze.
10	1:02 p. m.	+2.7	NW 3	8	8	Few Cu; light haze.
10	2:26½ p. m.	+3.6	NNW 3	8	8	Do.
11	1:34 a. m.	−5.5	NW 4	8	8	2 Cu; few Ci; light haze.
11	0:16 p. m.	−4.2	NW 4	8	9	1 Cu; light haze.
11	2:50 p. m.	−4.1	NW 5	8	10	2 Cu.
12	0:10 p. m.	+4.4	SW 5	6	8	4 Ci; moderate haze; prob. Ci. over sun.
12	3:30 p. m.	+6.1	SW 5	6	8	1 Ci; light haze.
16	3:39 a. m.	−3.1	NW 3	6	7	2 Ci; moderate haze.
17	2:37 a. m.	−3.3	NNW 6	7	9	Few Cu; few Ci; light haze to north.
17	0:54 a. m.	−3.3	NNW 6	7	10	Few Cu; few Ci.
17[1]	0:43 a. m.	−3.3	NNW 6	7	10	Do.
17	2:24 p. m.	−0.2	NNW 5	7	10	Few Ci; light haze to north.
17	3:37 p. m.	+1.1	NNW 5	7	10	Do.
19	3:38 a. m.	−1.9	NW 2	7	6	Zero clouds; moderate haze.
19	0:41 a. m.	+3.6	NNW 1	7	6	Do.
19	1:14 p. m.	+6.6	NW 1	7	6	Do.
19	3:33 p. m.	+7.3	NNW 1	7	6	Do.
23	2:05 a. m.	+0.3	W 5	8	8	2 Cu; moderate haze to north.
23[1]	1:54 a. m.	+.3	W 5	8	8	2 Cu; moderate haze; instrument indoors.
23	1:35 p. m.	+1.6	W 5	8	8	Few Cu; moderate haze to north.
23	3:45½ p. m.	+3.4	W 4	8	8	Few Cu; light haze.
25	0:51 a. m.	−1.1	W 2	8	6	Few Ci; few Cu; moderate haze.
26	0:58 p. m.	+0.6	NW 4	7	8	5 Ci; 3 Cu; light haze.
27	0:37 a. m.	+0.6	W 6	8	10	1 Ci; few Cu; light haze to north.
27	1:45 p. m.	0.0	W 6	8	10	Few Ci; few Cu; light haze to north.
27	4:05 p. m.	−0.6	W 6	8	10	Do.
28	2:32 a. m.	−6.6	NNW 3	8	9	Few Ci.
28	0.58 a. m.	−4.7	NW 3	8	9	Do.
28[1]	0:42 a. m.	−4.7	NW 3	8	9	Few Ci; light haze to north.
28	1.43 p. m.	−2.2	E 2	8	9	1 Ci; light haze to north.

[1] Indicates Smithsonian observation.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic Diff. in longitude	Heliographic Longitude	Heliographic Latitude	Area Spot	Area Group	Total area for each day	Observatory
1937	h m							
Jan. 4	13 14	−7.0	175.7	−34.0		242		U. S. Naval.
		+17.5	200.2	+28.0	48			
		+19.0	201.7	−9.0	218			
		+24.0	206.7	+28.0	388		896	
Jan. 6	11 8	−31.0	126.5	−27.0		121		Do.
		−3.0	154.5	−17.5		145		
		+18.5	176.0	−36.0		145		
		+43.5	201.0	−10.0	291			
		+49.5	207.0	+26.0	436		1,138	
Jan. 8	13 26	−3.0	126.9	−26.5		194		Do.
		+25.0	154.9	−18.0		436		
		+46.0	175.9	−36.0		145		
		+47.0	176.9	+12.5		97		
		+71.0	200.9	−10.0	242			
		+80.0	209.9	+26.5	582		1,696	
Jan. 9	11 16	−77.0	40.9	−12.5	48			Do.
		−19.5	98.4	+10.0		48		
		+8.0	125.9	−26.5		170		
		+37.0	154.9	−18.5		485		
		+56.0	173.9	−34.0		97		
		+61.5	179.4	+12.0	73		921	
Jan. 10	13 5	−85.0	18.8	−10.0	371			Mt. Wilson.
		−82.0	21.8	−16.0		93		
		−64.0	39.8	−15.0		51		
		−5.0	98.8	+10.0		85		
		+6.0	109.8	−34.0		6		
		+12.0	115.8	−24.0		18		
		+23.0	126.8	−25.0		31		
		+52.0	155.8	−15.0		445		
		+62.0	165.8	+11.0	8			
		+72.0	175.8	−30.5	28			
		+80.0	183.8	+15.0	26		1,162	
Jan. 11	13 0	−80.0	10.6	−12.0		203		Do.
		−69.0	21.6	−8.0	297			
		−50.0	40.6	−13.0		32		
		+8.0	98.6	+10.5		64		
		+20.0	110.6	−24.0		11		
		+35.0	125.6	−25.0		12		
		+65.0	155.6	−15.0		491		
		+78.0	168.6	+10.0	4			
		+80.0	170.6	−32.0		21	1,135	

Positions and areas of sun spots—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h m							
Jan. 12	11 9	−62.0	16.5	−11.0		241		U. S. Naval.
		−54.0	24.5	−8.0	388			
		−39.0	39.5	−11.5		48		
		+26.0	104.5	+10.0	61			
		+78.0	156.5	−17.0		776	1,514	
Jan. 15	13 30	−69.0	328.7	+22.0	98			Mt. Wilson.
		−60.0	337.7	−15.0	77			
		−39.0	358.7	+23.0	36			
		−21.0	16.7	−12.0		275		
		−14.0	23.7	−8.0	335			
		+4.0	41.7	−14.0		38		
		+9.0	46.7	+19.0		34		
		+66.0	103.7	+9.5	17			
		+82.0	119.7	+18.0		110	1,020	
Jan. 16	11 12	−55.0	330.8	+23.0	145			U. S. Naval.
		−47.5	338.3	−15.0	97			
		−25.0	0.8	+24.0	36			
		−7.0	18.8	−11.0		291		
		−1.0	24.8	−7.5	388			
		+25.5	51.3	+19.5	48		1,005	
Jan. 17	11 30	−82.0	290.4	−18.0		419		Mount Wilson
		−63.0	309.4	−28.0		36		
		−57.0	315.4	+10.0		24		
		−42.0	330.4	+22.0	90			
		−34.0	338.4	−15.0	41			
		−14.0	358.4	+22.0		12		
		+2.0	14.4	−11.0		157		
		+4.0	16.4	−25.0		7		
		+12.0	24.4	−8.0	233			
		+30.0	42.4	−12.0	8			
		+35.0	47.4	+19.0	23		1,050	
Jan. 18	11 10	−75.0	284.4	−20.0		1,465		Do.
		−51.0	308.4	−28.0		12		
		−43.0	316.4	+8.0		38		
		−30.0	329.4	+21.0	107			
		−24.0	335.4	−16.0		16		
		+16.0	15.4	−12.0		72		
		+18.0	17.4	−24.0		4		
		+25.0	24.4	−8.0	296			
		+42.0	41.4	−11.0		30		
		+45.0	44.4	+20.0	4		2,044	
Jan. 19	18 40	−71.0	271.1	−18.0	104			Do.
		−55.0	287.1	−20.0		1,481		
		−22.0	320.1	+9.0		57		
		−12.0	330.1	+21.0		114		
		−8.0	334.1	−16.0		28		
		+25.0	7.1	+14.0		16		
		+32.0	14.1	−11.5		20		
		+42.0	24.1	−8.0	328			
		+59.0	41.1	−12.0		19	2,167	
Jan. 20	11 35	−64.0	268.9	−19.5		135		Do.
		−49.0	283.9	−20.0		1,362		
		−14.0	318.9	+9.0		43		
		−5.0	327.9	+21.0		65		
		+1.0	333.9	−17.0		38		
		+33.0	5.9	+14.5		19		
		+42.0	14.9	−12.0		14		
		+51.0	23.9	−7.0	268			
		+67.0	39.9	−11.0		34	1,978	
Jan. 21	12 45	−46.0	273.1	−18.0		96		Do.
		−35.0	284.1	−20.0		786		
		−30.0	289.1	+19.5		220		
		+2.0	321.1	+10.0	8			
		+11.0	330.1	+22.0		14		
		+20.0	339.1	−17.0		11		
		+32.0	351.1	+18.0		8		
		+46.0	5.1	+12.0		34		
		+65.0	24.1	−8.0	286		1,465	
Jan. 22	12 59	−67.0	258.8	+22.0		42		Do.
		−58.0	247.8	−12.0		40		
		−48.0	257.8	+21.0		80		
		−32.0	273.8	−17.0		256		
		−18.0	287.8	−18.0		1,093		
		−14.0	291.8	+19.0		422		
		+13.0	318.8	−15.0	5			
		+16.0	321.8	+9.0		60		
		+24.0	329.8	+22.0	108			
		+46.0	351.8	+15.0		43		
		+56.0	1.8	+9.0		205		
		+80.0	25.8	−7.0	291		2,645	
Jan. 23	12 30	−57.0	235.9	+23.0	19			Do.
		−37.0	255.9	+20.0		199		
		−20.0	272.9	−17.0		189		
		−5.0	287.9	−19.0		826		
		−3.0	289.9	+18.0		488		
		+26.0	318.9	−25.0		14		
		+28.0	320.9	+9.0	20			
		+36.0	328.9	+23.0		67		
		+59.0	351.9	+17.0		35		
		+70.0	2.9	+10.0		160	2,017	
Jan. 25	14 18	−76.0	189.6	−11.0		1,067		U. S. Naval.
		−75.0	190.6	+10.0	97			
		−65.0	200.6	−12.0	48			
		−62.0	203.6	+25.0		291		
		−28.0	237.6	+20.5	24			
		−5.0	260.6	+20.0		630		
		+9.5	275.1	−19.5		194		
		+15.0	280.6	−21.0		121		
		+19.5	285.1	−11.0		170		

Positions and areas of sun spots—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h m							
Jan. 25	14 18	+21.0	286.6	+21.0		145		
		+22.5	288.1	−20.5		388		
		+29.0	294.6	+17.0		291	3,466	
Jan. 26	12 45	−78.0	175.3	−15.0	30			Mount Wilson.
		−65.0	188.3	+16.0	31			
		−63.0	190.3	+8.0	75			
		−62.0	191.3	−23.0	9			
		−60.0	193.3	−12.0		1,041		
		−53.0	200.3	+18.0		56		
		−52.0	201.3	+25.0		297		
		−17.0	236.3	+22.0	14			
		−12.0	241.3	−24.0	4			
		+8.0	261.3	+20.0		482		
		+22.0	275.3	−16.0		139		
		+32.0	285.3	−10.0		124		
		+34.0	287.3	−18.0		199		
		+39.0	292.3	+18.0		305		
		+70.0	323.3	−23.0	19			
Jan. 27	11 7	−89.0	152.0	−20.0	485			U. S. Naval.
		−67.0	174.0	−13.5		121		
		−55.0	186.0	−13.0		194		
		−53.0	188.0	−21.5		121		
		−53.0	188.0	+17.0		145		
		−50.0	191.0	+9.0	97			
		−45.0	196.0	−11.0		1,164		
		−39.0	202.0	−11.0	48			
		−38.5	202.5	+25.0		194		
		−38.5	202.5	+18.0		339		
		+12.0	253.0	+21.0	48			
		+24.0	265.0	+20.5		582		
		+32.0	273.0	−17.5		97		
		+42.0	283.0	+21.0		145		
		+43.0	284.0	−11.0		194		
		+49.0	290.0	−20.0		145		
		+52.0	293.0	+16.5		291	4,410	
Jan. 28	9 30	−75.0	153.7	−17.0	481			Harvard.
		−52.0	176.7	−12.5	248			
		−41.0	187.7	−11.5	168			
		−41.0	187.7	+18.5	70			
		−39.0	189.7	−21.5		238		
		−37.0	191.7	+9.5	124			
		−34.5	194.2	−11.0		614		
		−29.5	199.2	−7.5		948		
		−26.0	202.7	+18.0	87			
		−23.0	205.7	+25.0		237		
		−19.5	209.2	+17.0		219		
		+34.0	262.7	+19.5		747		
		+42.0	270.7	+20.0	106		4,287	
Jan. 29	11 48	−79.0	135.3	+26.0	194			U. S. Naval.
		−67.0	147.3	+34.0	97			
		−61.0	153.3	−19.5	291			
		−39.0	175.3	−14.0		145		
		−29.0	185.3	+17.0	48			
		−25.0	189.3	−21.0		339		
		−24.0	190.3	+15.0	24			
		−24.0	190.3	+7.5	73			
		−20.0	194.3	−11.0		1,697		
		−11.0	203.3	+25.0		97		
		−10.0	204.3	+19.0		388		
		+7.0	221.3	+22.0		73		
		+39.0	253.3	+21.0	24			
		+48.0	262.3	+20.5		1,067		
		+60.0	274.3	−17.0	97		4,654	
Jan. 30	11 19	−69.0	132.4	+24.0	145			Do.
		−62.0	139.4	+26.0	291			
		−52.5	148.9	+34.0	48			
		−48.0	153.4	−19.5		291		
		−24.0	177.4	−14.5		291		
		−13.0	188.4	+17.0		73		
		−11.0	190.4	−21.0		436		
		−10.0	191.4	+8.0	73			
		−6.0	195.4	−11.0		1,842		
		+2.0	203.4	+24.5		97		
		+3.0	204.4	+18.5		485		
		+21.0	222.4	+22.0		145		
		+60.0	261.4	+20.5		1,212		
		+73.0	274.4	−17.5	97		5,526	
Jan. 31	10 0	−33.5	155.4	−18.5		192		Harvard.
		−23.0	165.9	−31.5	47			
		−11.0	177.9	−14.0		130		
		−4.0	184.9	−22.5		242		
		+3.0	191.9	+7.0	101			
		+3.5	192.4	−22.0		351		
		+7.0	195.9	−10.0		3,178		
		+12.5	201.4	+18.0		134		
		+15.5	204.4	+24.0	85			
		+19.0	207.9	+17.5		642		
		+32.0	220.9	+24.0		176		
		+37.5	226.4	+22.5		238		
		+72.0	260.9	+21.5		481	5,997	

Mean daily area for 23 days, 2,392.

NOTE.—The sunspot areas obtained at the Naval Observatory as published in the Monthly Weather Review prior to 1937 and in Publications of the U. S. Naval Observatory, Second Series, Vol. XII, are in error on account of the use of a wrong factor for conversion into millionths of the Sun's visible hemisphere. They may be corrected by multiplying them by 1.5708. This correction of course does not apply to areas furnished by the cooperating Observatories.

PROVISIONAL SUNSPOT RELATIVE NUMBERS, FEBRUARY 1937

[Dependent alone on observations at Zurich and its station at Arosa]

[Furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

February 1937	Relative numbers	February 1937	Relative numbers	February 1937	Relative numbers
1	*a* 211	11	*a* ---	21	*a* 130
2	224	12	*Macd* 77	22	*add* 167
3	*a* 181	13	---	23	*a* 155
4	*Ec* 152	14	89	24	*ad* 164
5	*a* 146	15	79	25	*aa* 164
6	*Wc* ---	16	*d* 101	26	*Eac* 167
7	98	17	92	27	149
8	*Ec* 90	18	*ad* 88	28	*Wac* ---
9	*Ec* 76	19	*d* 97		
10	---	20	*d* 100		

Mean, 23 days = 130.3.

a = Passage of an average-sized group through the central meridian.
b = Passage of a large group or spot through the central meridian.
c = New formation of a group developing into a middle sized or large center of activity. E: on the eastern part of the sun's disk, W: on the western part, M: in the central circle zone.
d = Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. P. HARRISON

Mean free-air data based on airplane weather observations during the month of February 1937 are given in tables 1–3 hereunder. A description of the methods by which the various monthly means and normals therein are computed may be found in this section of the MONTHLY WEATHER REVIEW for January 1937.

It will be noted that many of the "normals" are based on only 3 years of observations. Conclusions based on departures from such short-period "normals" must be used with caution.

The mean surface temperatures for February (see chart 1) were generally above normal over the Great Lakes and northeast sections of the country as well as in Texas, Oklahoma, and eastern New Mexico and Arizona; also in southern Florida and a small area in South Dakota and Wyoming. The mean surface temperatures in the remainder of the country were generally below normal. The largest positive departures at the surface were principally concentrated in the immediate vicinity of the Great Lakes and east thereof, with values ranging from less than +1° C. to about +3.7° C., the latter prevailing on the northern New England coast. The positive departures elsewhere averaged nearly 1° C. The largest negative departures at the surface were confined to portions of the Western Plateau Region, with values ranging from −1° C. to −4° C. Elsewhere the negative departures were close to −1° C., except in the north-central part of the country where −2° C. was near the lower limit.

The mean free-air temperatures for the month up to 5 km above sea level (see table 1) generally did not depart very much from normal. Departures of this element from normal were mostly positive by slight amounts over the eastern part of the country, with maxima at Lakehurst, N. J., and Wright Field (Dayton), Ohio (+1.9° to +2.9° C., and 1.4° to 2.4° C., respectively, at all levels up to 5 km). The appreciable negative departures found at the surface in the north-central part of the country apparently were not merely confined to the surface, as shown by the departures of −2° to −2.7° C. from 1 to 5 km at Omaha, Nebr. Elsewhere the deviations from normal temperature were not notable except perhaps at Kelly Field (San Antonio), Tex., in the upper strata (+1.1° to 2.3° C. from 3 to 5 km).

The mean free-air relative humidities and specific humidities are given in table 2. In the eastern part of the country, except perhaps in the extreme southeast, the mean relative humidities were generally below normal by slight to moderate amounts (−2 to −12 percent) at almost all elevations up to 5 km, with most marked negative departures at Washington, D. C. where values from −10 to −12 percent prevailed in the stratum 1.5 to 3 km. In the north-central part of the country, Omaha, Nebr., showed slight positive departures (+1 to +5 percent) in humidity at all levels up to 5 km, hence of opposite sign to the departures of temperature from normal noted previously. In the northwest slight to moderate excesses over normal humidities generally prevailed. By comparison of the relative humidities for Salt Lake City, Utah, with those for surrounding stations, it may be inferred that they were at least moderately in excess of the normal at practically all elevations up to 5 km. On the southern California coast the humidities near the surface were moderately greater than normal, but approximately normal at greater elevations as shown by the results for San Diego, Calif. Elsewhere the departures of relative humidity did not appear significant.

Table 3 shows the monthly mean free-air barometric pressures and equivalent potential temperatures. The place of lowest average pressure during February at elevations up to 5 km, with the exception of the very lowest stratum near the ground, was located in the vicinity of Sault Ste. Marie, Mich., hence somewhat to the east of its position in January when it was centered over Fargo, N. Dak. However, it may be noted that the gradient between these two stations was relatively small in February (difference 3 to 1 mb). The (statistical) center of highest average pressure occurred over the region near Miami, Fla.

The (mean) isobaric charts for February were in marked contrast to those for the preceding month. Cyclonic curvature of the isobars of less notable degree than in January prevailed in the north-central portion of the country, while in the southern portion the isobars were straight east to west on the average instead of southwest to northeast or anticyclonic in the southeastern portion as in the previous period. Moreover, there was some evidence that the isobars at elevations from 1.5 to 4 km were perturbed from an east-west trend over the Western Plateau Region, so that an anticyclonic curvature prevailed thereover with the maximum pressure centered in the southwest where approximately straight east-west isobars appeared.

Comparison of the pressure differences between Miami and Fargo during the months of January and February indicates that the average pressure gradient between these two stations was from 12 to 24 percent greater in the former than in the latter month in the stratum from 1 to 5 km above sea level. There was, however, very little change in the average gradient between Miami and Sault Ste. Marie during these two months, except perhaps that from 1 to 2 km it became about 2.5 to 5 percent larger in February than it was in January. The data for Oakland and Fargo indicate that the pressure gradient from the former to the latter became appreciably greater in the second month of the year than it was in the first (+60 to +12 percent from 1 to 5 km). On the other hand, the gradient from San Antonio to Oakland decreased somewhat (−12 to −38 percent in the stratum 1.5 to 5 km).

Table 4 shows the free-air resultant winds based on pilot balloon observations made near 5 a. m. (75th meridian time) during the month of February. Generally speaking, the directions of the resultant winds were approximately normal, except at some places along the Pacific coast and the west Gulf coast near the surface. In particular, at Oakland, Calif., from 0.5 to 4 km, the resultant winds for the month were oriented from about 90° to 30° counterclockwise from normal, hence with much more pronounced westerly components and subdued northerly components. On the other hand, at Seattle, Wash., from 0.5 to 4 km, the resultants were similarly oriented from about 10° to 90° (respectively), hence with more accentuated southerly components than usual and subdued westerly components.

The resultant wind velocities were significantly below normal along the northeastern coastal region, where a departure of as much as −8 m. p. s. occurred at 2.5 km over Newark, N. J. The regime of negative departures associated with that region extended over considerably larger areas with increase of height, as may be exemplified by the facts that at 0.5 km it was confined to the area north and east of a line running from northern Michigan to southern New England, while at 3 km the line of division ran from North Dakota to southern Georgia. The departures in the region just specified averaged perhaps −2 to −2.5 m. p. s.

In regions other than those just specified, positive departures from normal resultant velocities generally prevailed with a few minor exceptions. Positive departures were most outstanding at Seattle, Wash. (+3.5 to +6.6 m. p. s. from 1.5 to 3 km). It is perhaps significant that at 3 km, Miami, Fla., Pensacola, Fla., Oklahoma City, Okla., and Cheyenne, Wyo., had supernormal velocities by amounts ranging from +3.2 to +3.9 m. p. s.; while at 4 km, at Salt Lake City, Utah, Cheyenne, Wyo., and Albuquerque, N. Mex., the amounts were +4.1 to +4.7 m. p. s. Elsewhere they were not in general so pronounced.

Table 5 shows maximum free-air wind velocities and directions for various sections of the United States during February as determined by pilot balloon observations. The extreme maximum was 57.2 m. p. s. from the WNW at 8 km above sea level over Modena, Utah.

The mean monthly equivalent potential temperatures and specific humidities shown in tables 2 and 3, respectively, when regarded as semiconservative elements and plotted on charts, give support by their distribution to the conception of the general circulation for the month derived from the barometric and wind data already discussed. From these considerations it appears that there was slightly more than normal transport of relatively cold air across the west coast and the Northwest from the Pacific and western Canada, respectively, into the center of the country and thence eastward; while the transport of warm, moist, air from the Gulf of Mexico was decidedly deficient except in the extreme southeast.

The weather situations during February which gave rise to the conditions discussed above were radically different from those which prevailed in January; the North Pacific HIGH was not nearly so well developed, and was displaced considerably westward and somewhat southward. A number of cyclones, mostly in an occluded state, appeared along the Pacific Northwest coast, while a number of younger cyclones crossed the Pacific coast farther south. The majority of these disturbances appear to have originated as offshoots of the Aleutian LOW, with (relatively) warm N_{PP} and T_P air acting against colder P_P air. Alternating with these were a number of anticyclones from the Pacific, characterized by deep and extensive domes of P_P air. The interplay of the air masses thus brought into juxtaposition had as its consequence excessive precipitation along the entire west coast and over part of the central portion of the Western Plateau Region, accompanied by subnormal temperatures.

Shallow layers of cold Pc air from the northwest frequently spread over the central part of the country, reinforced by deeper strata of P_P or N_{PP} air lying thereover. These air masses moved as far as the Gulf of Mexico and on many occasions prevented the transport of warm, moist air from that region northward up over the center of the country. Moreover, the spread of subsiding Polar air masses over the Gulf doubtless contributed in no small measure to the dryness and lack of precipitation obtaining over a large portion of the watershed of the Mississippi River and its principal tributaries (see inset of chart V), since the fresh outbreaks of Polar air operated to reduce the efficiacy of the Gulf as a source region of T_G (or T_M) air masses which are generally so important for precipitation in central and eastern United States.

Wave cyclones forming along the front of polar air in the Gulf of Mexico and the extreme southeastern section of the country were instrumental in the occurrence of the excessive precipitation (100–400 percent of normal) in the latter area.

The occluded cyclones which passed along the northern tier of states, and the few younger and more energetic cyclones from the southwest which were associated with vigorous transport of T_P and T_G air as far as the Great Lakes, served to provide the abundant precipitation that took place over a part of the extreme North Central States.

TABLE 1.—*Mean free-air temperatures (t), °C. obtained by airplanes during February 1937. (Dep. represents departure from "normal" temperature)*

Stations	Altitude (meters) m. s. l.																	
	Surface			500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Number of obs.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Barksdale Field [1] (Shreveport), La. (52 m)	26	8.0		7.3		6.4		5.9		4.3		2.4		−0.1		−4.6			
Billings, Mont.[2] (1,089 m)	28	−8.3	+1.3					−5.3	+0.6	−6.1	+0.1	−8.4	−0.4	−11.4	−0.9	−17.3	−0.3	−23.6	0.0
Boston, Mass.[1] (5 m)	26	−1.4		−1.9		−3.9		−5.4		−6.6		−9.0		−11.5		−16.5		−25.2	
Cheyenne, Wyo.[2] (1,873 m)	28	−5.7	+0.7							−5.1	+0.4	−6.9	−1.3	−9.2	−1.0	−14.5	0.0	−21.5	+0.1
Coco Solo, Canal Zone [3] (15 m)	27	24.9		21.7		18.5		15.7		13.4		11.5		10.2		5.4		−0.2	
El Paso, Tex.[2] (1,194 m)	28	5.2						7.8		5.5		3.2		0.7		−4.3		−9.8	
Fargo, N. Dak.[2] (274 m)	26	−16.5	−0.2	−12.7	+1.0	−11.0	+1.2	−10.4	+1.1	−11.0	+1.1	−12.6	+0.9	−14.9	+0.7	−20.6	+0.5	−26.8	+0.4
Kelly Field (San Antonio), Tex.[1] (206 m)	25	7.8	+0.8	10.5	+0.8	10.2	−0.2	9.9	−0.1	8.2	−0.1	6.2	+0.5	3.9	+1.1	−2.0	+1.5	−8.2	+2.3
Lakehurst, N. J.[3] (39 m)	22	−1.4	+2.1	−1.5	+2.7	−3.2	+2.0	−4.0	+1.9	−5.2	+2.2	−7.3	+2.2	−9.3	+2.4	−15.5	+2.1	−19.6	+2.9
Maxwell Field (Montgomery), Ala.[1] (52 m)	22	7.5	+0.7	7.2	+0.2	5.9	+0.3	4.4	0.0	2.6	−0.1	1.1	+0.3	−0.4	+0.9	−5.2	+1.1	−10.9	+1.7
Miami, Fla.[3] (4 m)	28	16.3		17.4		14.8		12.9		11.3		9.0		6.0		1.0		−4.0	
Mitchel Field (Hempstead, Long Island), N. Y.[1] (29 m)	22	−2.1	+1.7	−0.9	+2.4	−2.6	+1.7	−3.9	+1.1	−5.7	+0.7	−7.8	+0.5	−9.8	+0.6	−15.8	−0.2		
Murfreesboro, Tenn.[2] (174 m)	25	4.6	+2.2	3.7	+1.6	2.6	+1.4	1.3	+1.0	−0.1	+0.9	−2.3	+0.8	−4.4	+0.8	−9.4	+1.1	−15.1	+1.5
Norfolk, Va.[2] (10 m)	16	2.7	−1.5	3.0	−1.2	1.0	−1.8	−0.7	−0.3	−1.7	−1.4	−3.9	−0.1	−6.2	−1.2	−12.4	−1.1	−15.4	+0.2
Oakland, Calif.[3] (2 m)	28	6.9		7.4		5.1		3.4		1.7		−0.4		−2.8		−8.2		−14.4	
Oklahoma City, Okla.[2] (391 m)	28	0.9	+0.7	2.3	+0.8	2.8	+0.6	3.1	+0.1	1.6	−0.3	−1.0	−0.6	−3.8	−0.5	−9.5	−0.2	−16.0	0.0
Omaha, Nebr.[2] (300 m)	28	−7.3	−0.5	−6.9	−0.9	−6.0	−2.0	−5.5	−2.2	−6.8	−2.7	−8.5	−2.5	−10.9	−2.3	−16.3	−1.9	−22.9	−2.1
Pensacola, Fla.[3] (13 m)	13	8.7		9.8		9.1		7.1		5.7		4.5		2.1		−3.3		−8.8	
St. Thomas, Virgin Islands [3] (8 m)	27	22.6		21.3		18.6		15.7		13.2		11.5		10.7		6.0		0.3	
Salt Lake City, Utah [2] (1,288 m)	28	−2.5						−0.6		−1.2		−3.7		−6.5		−12.1		−17.2	
San Diego, Calif.[3] (10 m)	24	9.0	−2.9	10.2	−1.7	9.2	−1.2	7.7	+0.5	5.8	0.0	3.8	+1.2	1.4	+0.1	−3.7	+1.3	−10.4	+1.3
Sault Ste. Marie, Mich.[2] (221 m)	25	−10.1		−8.3		−9.5		−10.8		−11.9		−13.6		−15.6		−21.0		−27.4	
Scott Field (Belleville), Ill.[1] (135 m)	21	−3.0		−2.8		−2.1		−2.6		−4.6		−6.1		−8.3		−14.0		−20.1	
Seattle, Wash.[3] (10 m)	9	3.9		2.4		0.2		−3.2		−6.2		−9.6		−13.1		−21.6			
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	25	−3.6		−3.5		−4.4		−5.1		−6.7		−9.1		−10.9		−16.1		−21.9	
Spokane, Wash.[2] (596 m)	28	−3.5	+1.3			−1.2	+2.2	−2.1	+1.9	−5.1	+0.6	−8.3	−0.2	−11.3	−0.5	−17.1	−0.4	−22.7	0.0
Washington, D. C.[3] (13 m)	23	0.0	+0.8	−0.7	+0.2	−2.7	−0.5	−4.2	0.0	−5.2	−0.4	−6.6	+0.2	−9.2	−0.6	−15.0	−1.6	−20.9	−1.5
Wright Field (Dayton), Ohio [1] (244 m)	24	−2.4	+1.9	−2.1	+2.4	−2.9	+2.0	−3.4	+1.6	−4.6	+1.5	−6.6	+1.5	−8.7	+1.4	−13.8	+1.4	−19.8	+1.4

NOTE.—Observations taken about 4 a. m., 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

[1] Army.
[2] Weather Bureau.
[3] Navy.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Billings, 82 (3); Cheyenne, 85 (3); Fargo, 78 (3); Kelly Field, 68 (3); Lakehurst, 59 (3); Maxwell Field, 65 (3); Mitchel Field, 70 (3); Murfreesboro, 79 (3); Norfolk, 77 (4); Oklahoma City, 81 (3); Omaha, 164 (6); San Diego, 161 (8); Spokane, 83 (3); Washington, 153 (9); Wright Field, 69 (3).

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during February 1937. (Dep. represents departure from "normal" relative humidity)*

Stations	Altitude (meters) m. s. l.																						
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
	Number of observations	q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.	
			Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.
Barksdale Field, La.	26	5.0	75		4.7	68		4.0	60		3.6	53		2.9	45		2.3	39		2.1	38		1.7	40				
Billings, Mont.	28	1.7	73	+9							1.9	62	+6	1.8	60	+7	1.7	61	+7	1.3	59	+3	1.0	64	+5	0.7	62	+4
Boston, Mass.	26	2.5	74		2.4	70		2.3	72		2.2	71		1.9	64		1.7	64		1.4	63		1.0	57		0.6	62	
Cheyenne, Wyo.	28	1.7	57	−4										1.9	56	−3	1.7	56	+1	1.1	55	+1	0.7	55	+3			
Coco Solo, Canal Zone	27	16.7	85		15.5	91		13.2	89		11.3	86		9.3	77		7.3	65		5.4	50		2.9	32		1.2	19	
El Paso, Tex.	28	3.2	51								3.6	46		3.0	42		2.5	39		2.2	38		1.5	33		1.0	32	
Fargo, N. Dak.	26	0.8	79	0	1.2	76	−1	1.4	72	+1	1.4	64	+1	1.3	58	+1	1.1	57	+3	1.0	57	+2	0.6	53	0	0.4	50	−1
Kelly Field, Tex.	25	5.2	78	−1	5.8	70	−2	5.4	64	+1	4.7	52	0	4.4	52	+5	3.8	48	+3	3.2	46	+2	2.3	43	+2	1.6	42	+1
Lakehurst, N. J.	22	2.5	71	+4	2.2	57	−3	1.9	54	−2	1.8	49	−4	1.6	42	−7	1.5	44	−4	1.4	46	0	1.0	44	+1	0.1	20	−9
Maxwell Field, Ala.	22	4.4	68	−2	3.9	58	−1	3.3	52	0	2.9	47	+1	2.6	44	+3	2.0	35	−1	1.7	33	−2	1.5	34	+3	1.0	36	+2
Miami, Fla.	28	9.8	87		9.9	76		8.6	73		6.7	62		5.4	52		4.9	50		4.3	51		3.4	51		2.7	51	
Mitchel Field, N. Y.	22	2.3	71	0	2.4	63	−2	2.0	57	−4	1.9	56	−3	1.8	55	−4	1.5	50	−8	1.3	47	−8	0.9	48	−5			
Murfreesboro, Tenn.	25	3.8	70	−6	3.7	70	−3	3.3	65	−4	2.7	54	−7	2.0	45	−10	2.0	45	−8	1.7	44	−7	1.3	43	−7	1.0	48	−3
Norfolk, Va.	16	3.9	75	0	3.7	61	−4	3.1	58	−3	2.7	55	−3	2.5	49	−3	2.0	44	−6	1.7	42	−6	1.2	44	0	1.6	62	+11
Oakland, Calif.	28	5.4	87		5.0	74		4.3	70		3.6	61		3.0	55		2.5	50		2.1	47		1.6	49		1.1	49	
Oklahoma City, Okla.	28	3.0	74	+2	3.1	67	0	2.8	54	−2	2.5	45	−3	2.1	41	−2	1.9	38	−4	1.6	37	−5	1.1	38	−4	0.8	40	−2
Omaha, Nebr.	28	1.8	83	+5	1.8	78	+4	1.9	68	+5	1.9	61	+4	1.6	57	+4	1.5	54	+1	1.3	54	+1	0.9	54	+2	0.6	51	+3
Pensacola, Fla.	13	6.4	85		6.5	76		6.0	72		5.3	68		4.8	65		4.0	57		3.2	50		2.1	44		2.6	48	
St. Thomas, Virgin Islands	27	15.4	91		14.7	89		12.8	87		10.6	82		8.5	72		6.4	58		4.7	41		2.4	26		1.1	18	
Salt Lake City, Utah	28	2.7	74								3.0	70		2.8	65		2.6	66		2.2	65		1.6	64		1.1	60	
San Diego, Calif.	24	5.9	84	+8	5.9	72	+5	5.0	61	+3	4.1	52	0	3.4	46	+2	2.6	40	−1	2.2	37	+2	1.7	35	−2	1.0	33	−3
Sault Ste. Marie, Mich.	25	1.4	82		1.7	78		1.6	74		1.4	68		1.2	60		1.1	60		1.0	62		0.7	60		0.5	64	
Scott Field, Ill.	21	2.3	73		2.3	68		2.2	59		1.8	50		1.7	48		1.6	47		1.4	45		1.0	46		0.7	49	
Seattle, Wash.	9	4.1	81		3.5	74		2.9	68		2.2	65		1.8	62		1.4	60		1.2	59		0.6	57				
Selfridge Field, Mich.	25	2.3	79		2.3	76		2.1	69		1.7	56		1.4	50		1.3	50		1.2	49		0.9	51		0.7	54	
Spokane, Wash.	28	2.6	82	0				2.8	74	−2	2.7	68	−1	2.3	68	+2	1.8	68	+4	1.6	65	+4	1.0	63	+5	0.7	59	+4
Washington, D. C.	23	2.5	67	−4	2.1	55	−8	1.9	53	−7	1.6	49	−11	1.4	42	−12	1.3	42	−10	1.1	42	−12	0.9	45	−5	0.5	44	−2
Wright Field, Ohio	24	2.5	76	−1	2.6	74	−3	2.4	68	−5	2.0	55	−9	1.6	47	−9	1.5	45	−9	1.2	45	−8	1.1	52	+1	0.9	56	+5

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (Θ_E), in °A, obtained by airplanes during February 1937*

Stations	Altitude (meters) m. s. l.																			
	Surface			500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Number of observations	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	
Barksdale Field, La	26	1,013	294	960	297	904	299	850	303	800	305	752	306	706	309	622	313			
Billings, Mont	28	888	279					842	287	790	291	741	294	695	294	609	298	533	301	
Boston, Mass	26	1,014	277	953	281	895	284	840	288	788	291	739	293	693	295	608	299	533	299	
Cheyenne, Wyo	28	806	290							793	292	743	295	697	298	611	302	535	304	
Coco Solo, Canal Zone	27	1,010	344	954	343	907	338	848	336	800	333	753	330	709	330	628	328	556	327	
El Paso, Tex	28	883	298					850	305	800	306	752	308	707	310	624	313	550	316	
Fargo, N. Dak	26	983	260	954	267	894	275	838	280	786	285	736	288	689	290	603	294	525	298	
Kelly Field, Tex	25	996	296	962	303	907	307	853	310	804	313	756	315	711	316	628	317	554	319	
Lakehurst, N. J	22	1,013	277	956	281	898	284	843	288	791	291	742	294	697	297	611	300	536	304	
Maxwell Field, Ala	22	1,014	292	961	295	904	297	850	299	800	302	751	304	706	307	622	312	548	315	
Miami, Fla	28	1,018	315	961	322	907	320	855	319	806	319	758	320	714	321	632	324	558	327	
Mitchel Field, N. Y	22	1,013	277	955	282	897	285	842	288	791	292	741	294	695	297	610	300			
Murfreesboro, Tenn	25	998	288	959	291	902	294	848	296	797	298	748	300	703	303	618	307	543	311	
Norfolk, Va	16	1,018	285	958	290	901	291	846	294	795	297	746	299	700	301	614	304	541	312	
Oakland, Calif	28	1,019	293	958	298	902	299	848	301	797	303	749	304	704	305	620	309	544	312	
Okalhoma City, Okla	28	972	285	958	288	901	292	847	297	796	300	748	302	703	303	618	306	543	309	
Omaha, Nebr	28	981	272	956	275	896	281	841	287	789	290	739	293	693	295	608	299	531	302	
Pensacola, Fla	13	1,020	296	963	304	907	307	853	308	802	311	754	313	709	314	626	316	552	322	
St. Thomas, Virgin Islands	27	1,016	337	962	340	908	337	856	333	807	329	760	328	715	327	634	326	561	327	
Salt Lake City, Utah	28	871	290					848	294	797	299	748	300	703	302	617	305	541	309	
San Diego, Calif	24	1,018	297	960	304	903	305	850	306	800	308	752	309	707	311	624	314	549	316	
Sault Ste. Marie, Mich	25	987	268	952	274	892	277	836	280	783	284	733	287	687	290	600	294	524	298	
Scott Field, Ill	21	1,004	276	958	280	898	286	843	289	791	292	741	296	696	298	610	302	536	305	
Seattle, Wash	9	1,014	287	953	289	895	290	840	290	789	291	739	292	692	292	607	292			
Selfridge Field, Mich	25	993	276	954	280	895	283	841	287	789	289	740	292	694	294	608	299	532	304	
Spokane, Wash	28	942	281			896	289	842	293	790	293	741	294	695	296	608	299	532	303	
Washington, D. C	23	1,019	279	956	282	898	285	843	287	791	291	742	294	696	296	610	301	535	304	
Wright Field, Ohio	24	988	278	956	282	898	286	843	289	792	292	743	295	697	297	611	302	536	306	

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TABLE 1.—*Mean free-air temperatures (t), °C. obtained by airplanes during January 1937. (Dep. represents departure from "normal" temperature)*

Station	Altitude (meters) m. s. l.																		
	Number of observations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Coco Solo, Canal Zone [1] (15 m)	29	24.2	------	22.1	------	19.1	------	16.2	------	13.8	------	11.7	------	9.3	------	3.6	------	−2.6	------

[1] Navy.

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TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during January 1937. (Dep. represents departure from "normal" relative humidity.)*

Station	Number of observations	Altitude (meters) m. s. l.																					
		Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.		q	R. H.	
			Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.		Mean	Dep.
Coco Solo, Canal Zone	29	17.2	91	----	15.8	90	----	13.9	89	----	12.0	88	----	10.3	83	----	7.8	68	----	5.5	54	----	4.0	50	----	2.4	42	----

LATE REPORT

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (Θ_E), in °A. obtained by airplanes during January 1937*

Station	Altitude (meters) m. s. l.																		
	Number of observations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E
Coco Solo, Canal Zone	29	1,008	345	952	344	898	341	847	338	798	337	752	333	708	329	626	329	554	329

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during February 1937*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)		Detroit, Mich. (204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	331	2.2	296	2.5	263	3.4	310	2.5	267	4.9	249	3.4	-----	-----	238	2.4	282	2.3	39	1.8	98	1.5	169	0.8	208	0.9
500	-----	-----	282	3.3	-----	-----	321	5.2	-----	-----	259	6.6	-----	-----	243	5.4	290	3.6	94	1.1	113	3.3	176	1.2	215	5.0
1,000	-----	-----	292	5.6	-----	-----	304	5.5	-----	-----	272	11.8	-----	-----	256	9.7	299	6.4	267	2.0	162	1.7	180	2.3	240	8.2
1,500	-----	-----	277	8.6	243	8.3	298	7.8	-----	-----	283	10.5	-----	-----	254	10.3	300	8.3	286	6.2	252	3.3	225	4.5	267	8.9
2,000	310	3.9	281	11.5	271	8.1	288	9.5	269	7.1	292	10.8	-----	-----	268	10.7	288	10.7	281	6.4	263	4.9	240	5.5	277	10.4
2,500	294	6.4	288	12.2	280	9.4	298	9.3	280	13.2	303	11.1	-----	-----	297	10.7	293	11.7	287	9.3	270	6.1	258	6.9	285	12.4
3,000	291	9.8	279	11.1	284	12.2	303	7.8	288	16.0	314	7.4	-----	-----	-----	-----	298	10.2	295	9.6	289	7.5	269	5.7	279	10.7
4,000	290	15.4	-----	-----	290	14.7	-----	-----	285	15.4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
5,000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

Altitude (meters) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Peral Harbor, Territory of Hawaii[1] (68m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)		Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	299	3.2	109	0.7	58	0.4	315	1.8	-----	-----	4	3.5	269	2.5	154	3.0	350	0.6	23	0.2	164	0.9	211	1.3	307	2.1
500	310	6.6	263	0.8	210	2.2	303	4.0	-----	-----	40	0.6	262	6.0	-----	-----	309	1.3	243	1.1	183	3.6	-----	-----	298	6.3
1,000	309	7.3	260	2.3	241	4.8	299	7.4	-----	-----	274	3.0	278	9.4	-----	-----	336	0.7	277	3.2	185	6.3	222	3.2	301	7.9
1,500	296	8.2	235	3.2	270	5.2	300	11.2	-----	-----	288	5.9	286	10.7	166	5.1	226	0.7	306	5.7	186	7.0	240	5.8	299	8.1
2,000	294	5.5	252	2.6	286	7.7	299	11.9	-----	-----	287	7.5	281	11.4	191	6.5	290	1.5	323	7.3	196	8.7	242	6.4	278	9.1
2,500	298	3.7	273	2.5	287	11.8	298	11.3	-----	-----	285	10.1	291	14.0	237	5.4	302	3.1	303	7.2	187	8.7	260	7.8	245	8.8
3,000	304	5.3	295	3.2	290	12.5	278	8.8	-----	-----	276	11.0	280	11.3	255	7.4	311	4.8	335	6.9	198	10.0	245	7.0	-----	-----
4,000	-----	-----	293	5.2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	280	10.7	299	6.5	-----	-----	-----	-----	-----	-----	-----	-----
5,000	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	281	5.1	-----	-----	-----	-----	-----	-----	-----	-----

[1] Navy stations.

TABLE 5.—*Maximum free-air wind velocities, (M. P. S.), for different sections of the United States based on pilot balloon observations during February 1937*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station
Northeast [1]	44.0	SW	1,600	8	Cleveland, Ohio	49.2	WSW	4,310	9	Columbus, Ohio	30.6	NNW	8,380	19	Boston, Mass.
East-Central [2]	41.6	SW	1,650	8	Knoxville, Tenn	50.2	NW	2,550	14	Knoxville, Tenn	54.4	WNW	5,580	26	Greensboro, N. C.
Southeast [3]	41.8	W	2,320	25	Spartanburg, S. C	41.0	W	3,040	25	Spartanburg, S. C	46.6	WNW	8,220	17	Charleston, S. C.
North-Central [4]	37.7	NW	1,510	13	Bismarck, N. Dak	41.3	WSW	5,000	9	Detroit, Mich	44.0	WSW	5,510	9	Detroit, Mich.
Central [5]	44.5	NW	2,420	14	St. Louis, Mo	51.5	WSW	4,570	9	Indianapolis, Ind	41.6	WSW	5,560	9	Indianapolis, Ind.
South-Central [6]	36.5	W	2,090	21	Houston, Tex	40.0	WSW	4,850	9	Memphis, Tenn	55.2	WSW	7,690	9	Oklahoma City, Okla.
Northwest [7]	47.3	SW	1,440	17	Pendleton, Oreg	54.0	WNW	4,290	12	Spokane, Wash	41.0	WNW	5,980	16	Boise, Idaho.
West-Central [8]	34.8	W	2,480	5	Cheyenne, Wyo	48.9	NNE	3,010	14	Redding, Calif	57.2	WNW	8,050	3	Modena, Utah.
Southwest [9]	40.7	WNW	1,970	20	Albuquerque, N. Mex.	41.0	WSW	3,560	7	Winslow, Ariz	56.2	WSW	5,720	26	Winslow, Ariz.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania and Northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas and Missouri.
[6] Mississippi, Arkansas, Louisana, Oklahoma, Texas (except El Paso), and Western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, Northern Nevada and Northern California.
[9] Southern California, Southern Nevada, Arizona, New Mexico, and extreme West Texas.

RIVERS AND FLOODS

[River and Flood Division, W. J. MOXOM temporarily in charge]

By BENNETT SWENSON

The outstanding feature of the floods that occurred during the months of January and February 1937 was the unprecedented flood in the Ohio and lower Mississippi Valleys. Floods of lesser severity occurred elsewhere over the country; and in the following discussion of the important features, causes, etc., of all the floods that occurred during January and February, the floods have been arranged according to drainage areas. Reports by the officials of the various district centers in the Ohio and lower Mississippi Valleys have been added to the discussion of the Ohio-Mississippi flood.

ST. LAWRENCE DRAINAGE

Minor flooding occurred in the Maumee Valley in Indiana and Ohio near the middle of January. No damage of consequence was incurred.

ATLANTIC SLOPE DRAINAGE

Precipitation was above normal over most of the Atlantic Slope Drainage during January, ranging from normal to as much as twice normal or more over portions of the Middle Atlantic States. The precipitation was quite evenly distributed over the whole month so that, although flooding occurred in the upper Susquehanna River and tributaries in New York and in all the rivers from the Potomac River southward to Florida, no serious flooding resulted.

Additional heavy rains during February, which occurred on the 8th and 9th and again on the 20th and 21st, again brought most of these rivers slightly above flood stage.

No losses of consequence were reported in the river basins with the exception of the following: Roanoke River, about $73,000; Neuse River, $14,000; and the Peedee River, $13,000, all mostly due to suspension of business; Santee River, $25,000, mostly to crops and suspension of logging industry; and Altamaha River, about $25,000.

EAST GULF OF MEXICO DRAINAGE

The rainfall was above normal over the northern portion of the drainage area during January and in portions of Mississippi it was more than three times normal. During February the southeastern portion of the drainage area received normal to slightly above normal precipitation.

The lower portion of the Apalachicola River reached flood stage on January 4 and continued above flood stage at the close of February, with only a slight interruption on February 20. The flooding was not serious, however, and no damage of consequence was reported.

Minor flooding occurred in the Alabama River and its tributaries during January, and only slight damage was caused by flooding of the lowlands.

Heavy rains on January 1 and 2 over the entire watersheds of both the Black Warrior and Tombigbee Rivers were followed by rapid rises throughout the entire system and the Black Warrior at Tuscaloosa, Ala., reached a crest nearly 13 feet above flood stage on January 3. Heavy rains occurred again at frequent intervals during the month of January and the Tombigbee River continued to rise steadily until the first part of February, when a crest stage of nearly 25 feet above flood stage was reached at Lock No. 3.

The flooding in the Tombigbee River continued through most of February and at some points the stages were still above flood stage at the close of February. As there were no crops planted, the damage was small, the larger part being the loss of wages due to suspension of lumbering operations. The total losses reported were about $16,000.

Unusually heavy rain occurred over much of the Pascagoula and Pearl River watersheds during January. The heaviest rainfall reported for the month was at Hickory, Miss., where 21.48 inches was recorded. At Meridian, Miss., slightly less, 18.77 inches, was recorded.

The rainfall, however, was very well distributed throughout the month, thus resulting in relatively moderate floods and the damage was not great. The total loss reported for the Pascagoula and Pearl River systems was slightly less than $50,000.

UPPER MISSISSIPPI DRAINAGE

Minor floods occurred during January in the Illinois, Meramec, and Bourbeuse Rivers. They were due mostly to thawing and ice movements. No damage of consequence was reported.

Moderate to heavy rains began over southeastern Iowa, northern Illinois, and southern Wisconsin on February 19, becoming heaviest on the 20th and 21st, and continuing into the 22d. The snow cover varied from moderately heavy to light in this region. The heavy rains and moderate temperatures melted the ice and snow and the runoff was rapid. The streams began swelling, breaking up the ice and forming gorges. Rather severe flooding resulted, principally from the forming and breaking of ice gorges, in most of the rivers in this area. As the flooding continued into March in some places a more complete report on these floods will be given in the March number of the REVIEW.

The stages in the upper Mississippi River remained quite low during the month of January and the first part of February, but a rise began the latter part of February. Stages did not exceed flood stage, however, except at Keithsburg, Ill., where a stage 0.3 foot above flood stage was reached on February 25.

MISSOURI DRAINAGE

The only flooding during January occurred on the 31st, when the Grand River was in flood at Chillicothe, Mo. No damage occurred.

A more general flood occurred in February in the Grand River. The flood was light except at Chillicothe, Mo., where two crests occurred, on February 12–13 and again on February 18–19, with stages 8 or 9 feet above flood stage. No great amount of damage occurred, due largely to the time of the year.

The outstanding fact about the floods of January and February in the Grand River was their frequency when due almost entirely to melting of sleet, snow, and ice.

The lowest stage of record on the Missouri River at Kansas City, Mo., occurred on January 9 and 10. The gage reading was 2.7 feet below zero.

OHIO DRAINAGE

The great flood of January–February 1937 in the Ohio Valley actually had its beginning in the latter part of December 1936, when moderate to heavy rains began over the entire Ohio River watershed. After several months of comparatively low stages in the Ohio River a general rise began in the lower portion during the last week of December 1936 and developed within 1 month's time into the greatest flood of record.

The flood resulted from excessive rains which followed during the month of January. There was practically no snow on the ground at the beginning of the month and whatever amounts fell subsequently were absorbed in the general rains or floods, and had no appreciable effect on the flood.

Figure 1 shows that the area of excessive precipitation coincided almost exactly with the drainage basins of the Ohio River and the upper portion of the lower Mississippi River; the greatest concentration occurring in the lower portions of the Ohio Valley. The total precipitation for January in this latter area was more than four times the amount of precipitation which normally occurs during the month.

The cause of the abnormal weather during January 1937 has been described by C. L. Mitchell, Forecaster, Washington Forecast District, as follows:

> During almost the entire month of January, an abnormal barometric pressure distribution prevailed over most of the northern hemisphere. Inasmuch as the movements of air masses, as shown by the wind directions and speeds, are determined by pressure gradients, the weather conditions resulting from the movements and interactions of the air masses, have likewise been abnormal over large areas. These unusual weather conditions, insofar as they affected the United States, can be summarized briefly as follows:
>
> Pressure was persistently and abnormally high at, and up to at least 3 miles above, the surface of the earth from the south Atlantic States and the eastern Gulf of Mexico eastward over the Bahamas and the region of Bermuda, as well as over the Pacific Ocean west of our coast and northeast of the Hawaiian Islands. This pressure distribution resulted in a continuous northward and northeastward movement of tropical air masses over the area roughly from Louisiana and Tennessee eastward to the Atlantic States, New England, and New York, while air masses of polar origin moved southward almost continuously over much of the western half of the United States. Consequently, the month of January was abnormally warm in the East and South and abnormally cold in the Pacific States, the Plateau and Rocky Mountain regions, the Plains States, and, at times, the upper Mississippi Valley.
>
> The extremely heavy rainfall over the Ohio Valley, Tennessee, and Arkansas and part of the adjoining areas was in general caused by the fact that this area was so located with relation to the very deep areas of high pressure on either side that at the earth's surface the line of contact between the warm, moist air from the south, and the dense, cold air of polar origin that came in over the Ohio and middle Mississippi Valleys on many days from the north and northeast, lay somewhere over this area much of the time; and the less dense warm air from the south (or southwest) was forced to rise over the cold and denser air. The rapid lifting of the very moist air of tropical origin resulted in abundant precipitation.

Heavy rain occurred over the Cumberland and Tennessee River basins during the night of January 1. The amounts were slightly in excess of 4 inches at some points. This occurred on rising rivers and quickly brought both the Cumberland and Tennessee Rivers to flood. The stages on these rivers fell slightly below flood stage about the middle of the month but rose quickly when the rains again increased. The Wabash River was at high stage at the close of December and with additional rains the first part of January the river reached flood stage and remained in flood most of the month.

Thus, the lower Ohio River was receiving considerable quantities of water from its three largest tributaries at the very beginning of January and it continued to rise at a steady rate. As early as January 8 portions of the lower Ohio River were above flood stage and on the 10th the river was above flood stage from the mouth at Cairo, Ill., to Paducah, Ky., nearly up to flood stage from there to Louisville, Ky., and from one-half to two-thirds full from Louisville, Ky., to Pittsburgh, Pa. Table 1 gives the stages on the Ohio River on this date, as well as on several following dates.

TABLE 1.—*Stages of the Ohio River between 7 and 8 a. m. on 3 outstanding dates during the flood of 1937, and comparative data.*

[Jan. 10, above flood stage from Cairo, Ill., to Paducah, Ky. Jan. 18, above flood stage from Cairo, Ill., to Cincinnati, Ohio. Jan. 24, (Black Sunday) above previous records from Portsmouth, Ohio, to Cairo, Ill.]

Station	Flood stage	January 10	January 18	January 24	Crest and date	Previous highest and year	Height of crest above: Flood stage	Height of crest above: Previous highest
Pittsburgh, Pa.	25	19.0	22.0	29.2	34.5—Jan. 26	46.0—1936	9.5	
Dam No. 12, near Wheeling, W. Va.	36	19.8	28.2	45.0	48.7—Jan. 26	55.5—1936	12.7	
Parkersburg, W. Va.	36	18.0	35.0	50.6	55.4—Jan. 26	58.9—1913	19.4	
Point Pleasant, W. Va.	40	21.4	41.6	57.5	62.7—Jan. 27	62.8—1913	22.7	
Dam No. 28, at Huntington, W. Va.	50	23.7	46.6	63.3	69.3—Jan. 27	65.3—1913	19.3	4.0
Portsmouth, Ohio	50	28.0	50.0	68.7	74.1—Jan. 27	67.9—1913	24.1	6.2
Dam No. 33, near Maysville, Ky.	50	30.8	49.6	69.4	75.3—Jan. 27	68.4—1913	25.3	6.9
Cincinnati, Ohio	52	36.6	52.4	73.4	80.0—Jan. 26	71.1—1884	28.0	8.9
Louisville, Ky.:								
Upper gage	28	17.0	30.8	51.5	57.1—Jan. 27	46.7—1884	29.1	10.4
Low-water gage	51	36.7	53.8	[1] 75.4	81.4—Jan. 27	70.0—1884	30.4	11.4
Dam No. 45, Addison, Ky.	47	38.8	51.8	65.1	69.4—Jan. 28	60.9—1884	22.4	8.5
Evansville, Ind.	35	34.8	42.8	49.4	53.8—Jan. 31–Feb. 1	48.4—1913	18.8	5.4
Shawneetown, Ill.	33				65.5—Feb. 2 [2]	58.9—1913	32.5	6.6
Paducah, Ky.	39	[3] 39.0	[3] 44.7	[3] 55.8	60.6—Feb. 2 [3]	54.3—1913	21.6	6.3
Cairo, Ill.	40	40.8	47.8	56.8	59.6—Feb. 3–4	56.4—1927	19.6	3.2

[1] Approximated.
[2] Furnished by U. S. Engineer Office.
[3] Readings furnished by U. S. Geological Survey.

Practically all of the precipitation that occurred over the Ohio Valley during January occurred within the period from the 1st to the 24th, inclusive. During the first half of this period, 1st–12th, the rainfall was not abnormally heavy, nor was it concentrated over a small area. (See fig. 2.) However, during the second half, 13th–24th, inclusive, the rainfall was exceedingly heavy and the area of greatest intensity was located along the Ohio River from Cincinnati, Ohio, to the mouth, extending into Arkansas. (See fig. 3.) The axis of this area followed the Ohio River from Cincinnati, Ohio, to Louisville, Ky., and from there on it lay a very short distance south of the course of the main stream.

At the beginning of the second half of the January 1–24 period the rains increased in intensity and were heavy on the 13th and 14th, and again on the 17th. By the morn-

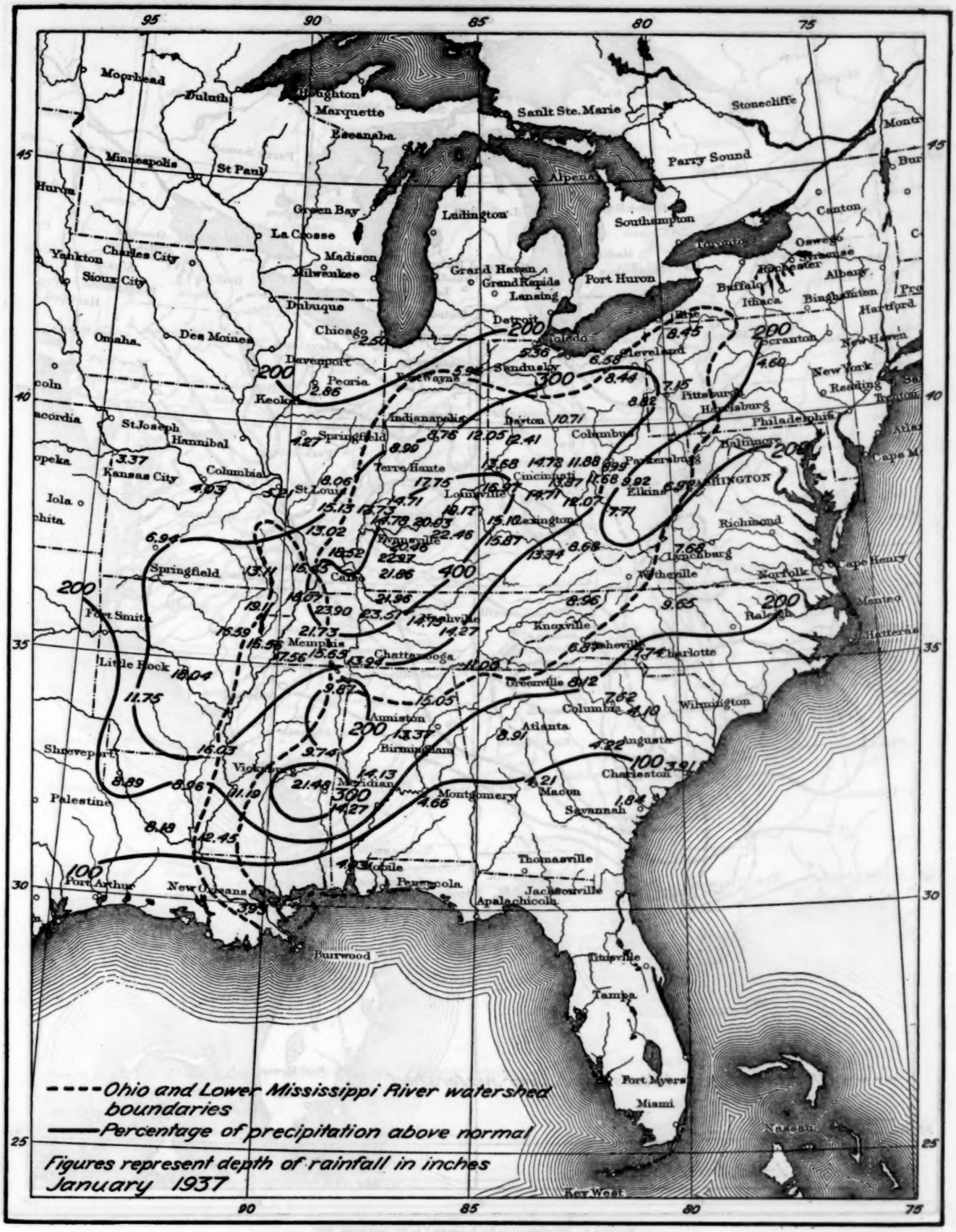

FIGURE 1.—Total precipitation for January 1937 and percentage above normal.

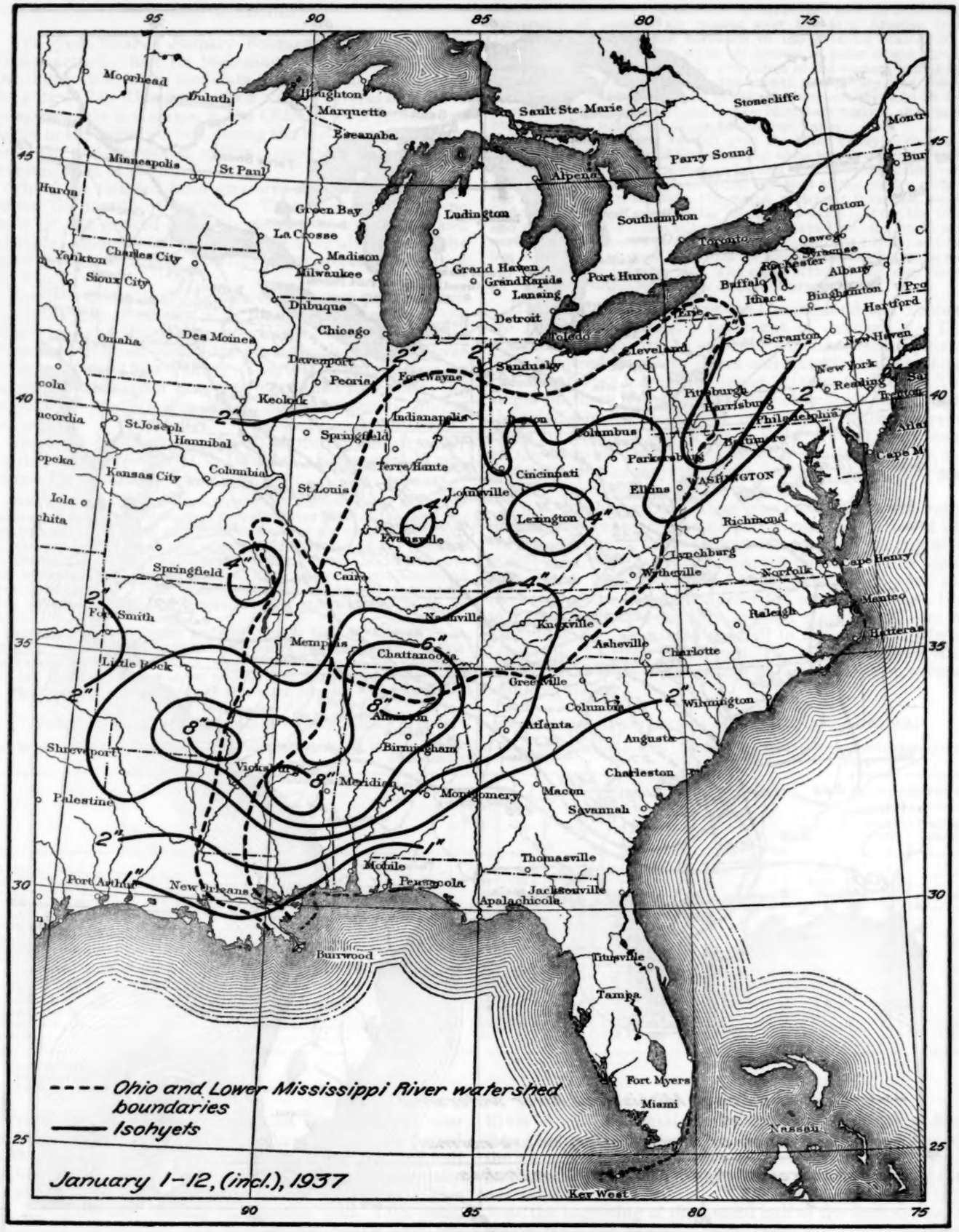

FIGURE 2.—Precipitation for January 1 to 12, inclusive, 1937.

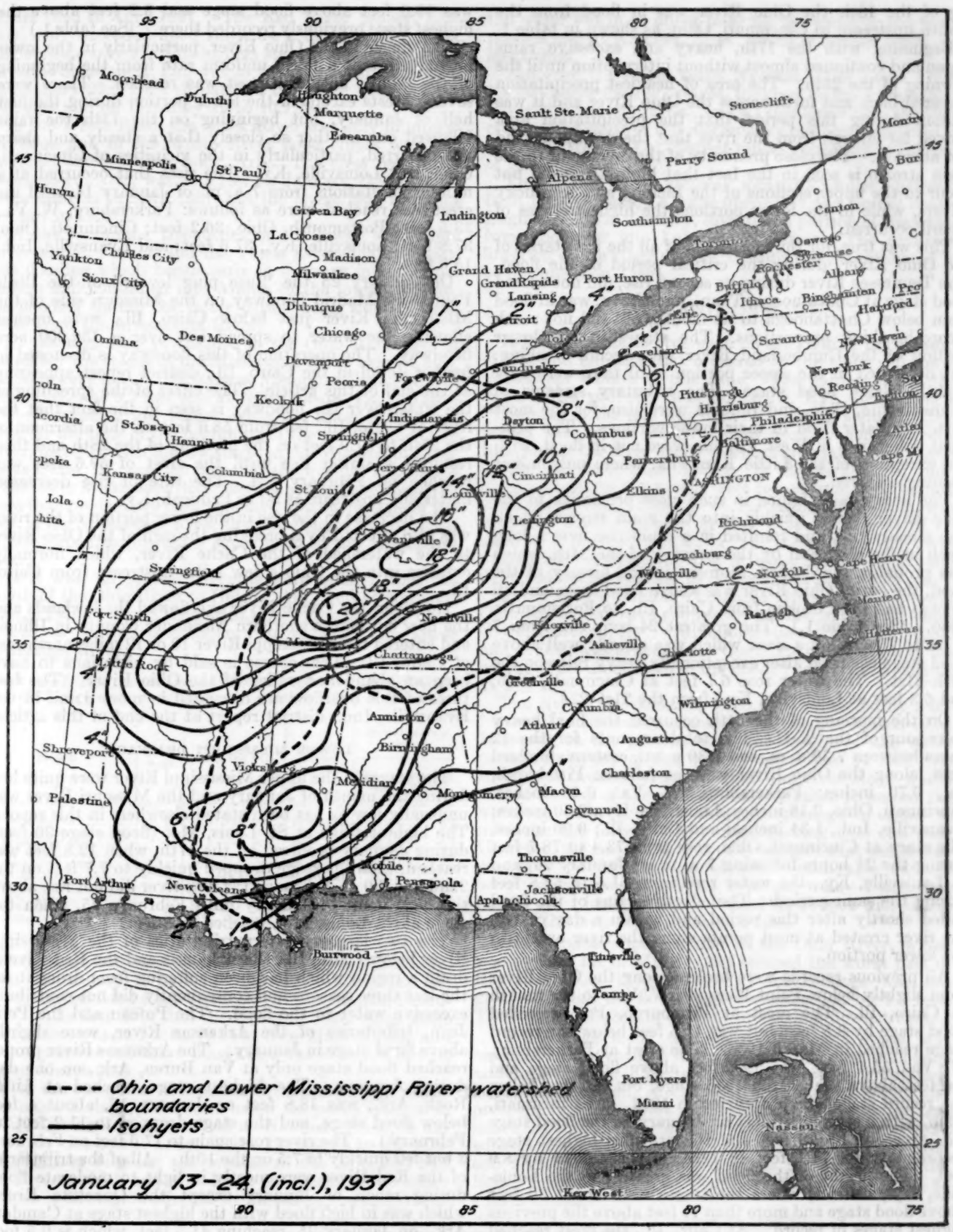

FIGURE 3.—Precipitation for January 13-24, inclusive, 1937.

ing of the 18th the Ohio River was in flood from the mouth upstream to Cincinnati, Ohio, as shown in table 1.

Beginning with the 17th, heavy and excessive rains began and continued almost without interruption until the morning of the 25th. The area of heaviest precipitation wavered back and forth across the Ohio River and it was seldom during this period that the precipitation area moved far enough from the river that the downpours did not affect it. The close proximity of the downpour to the main stream is seen in the fact that high stages did not occur in the upper sections of the Licking and Kentucky Rivers, while in the lower portions the highest stages of record occurred.

This was true, for the most part, of all the tributaries of the Ohio River, during the critical period of the flood. The Tennessee River during its second rise, did not exceed flood stage at Chattanooga, Tenn., and above; was in flood from below Chattanooga to its mouth, but did not reach record-breaking proportions. The stages in the lower portion of the Cumberland River were record-breaking, but decreased in the upper portion until they were only slightly above flood stage. The tributary streams in Pennsylvania, Ohio, and Indiana were also, for the most part, in greater flood in their lower portions. The principal tributaries in West Virginia were not in flood, with the exception of the Little Kanawha, where only minor flooding occurred.

The heavy rains falling in such close proximity to the Ohio River passed quickly into the main stream which was already full, and resulted in a rapid rise over a long reach in the river and by the morning of the 24th, which was probably the darkest moment in the history of the flood, the entire Ohio River was above flood stage and all records had been broken from Cairo, Ill., to Portsmouth, Ohio. (See table 1.) The greatest 24-hour rise from 7 a. m. to 7 a. m. on a river which was already well above flood stage occurred after exceptionally heavy rains on the 20th–21st. The water rose 6.7 feet at Cincinnati, Ohio, and 6.3 feet at Louisville, Ky., from the 21st–22d.

On the morning of the 24th occurred the final heavy downpour of the flood. The total amounts for the 12 hours between 7:30 a. m. and 7:30 p. m., eastern standard time, along the Ohio River were as follows: Pittsburgh, Pa., 0.70 inches; Parkersburg, W. Va., 0.46 inches; Cincinnati, Ohio, 2.18 inches; Louisville, Ky., 2.50 inches; Evansville, Ind., 1.34 inches; and Cairo, Ill., 0.90 inches. The stage at Cincinnati, Ohio, rose from 73.4 to 78.7 feet during the 24 hours following 7 a. m. of January 24, and at Louisville, Ky., the water rose from 51.5 to 54.8 feet during the same period. The effective rains of the flood ended shortly after this period and within a day or two the river crested at most points along the river except in the lower portion.

All previous records were broken along the Ohio River from slightly below Point Pleasant, W. Va., to the mouth at Cairo, Ill. The crest at Pittsburgh, Pa., exceeded flood stage by 9.5 feet, but was 11.5 feet below the record stage reached in March 1936. The crest at Parkersburg, W. Va., 55.4 feet, was 19.4 feet above flood stage and 7.4 feet above the March 1936 stage, but 3.5 feet below the record stage which occurred in 1913. At Cincinnati, Ohio, with a stage of 80 feet on January 26 the flood stage was exceeded by 28 feet and the previous highest stage recorded there, 71.1 feet in 1884, was exceeded by 8.9 feet. The height of the flood was greatest in the Louisville, Ky., district, where the stages were about 30 feet above flood stage and more than 11 feet above the previous highest stages of record. At Cairo, Ill., the crest reached was 19.6 feet above flood stage and 3.2 feet above the highest stage previously recorded there. (See table 1.)

The stages in the Ohio River, particularly in the lower portion, rose at a fairly uniform rate from the beginning of the month until the crest was reached. There were several crests except in the lower portion during the first half of January, but beginning on the 13th the rains followed one another so closely that a steady and sharp rise occurred, particularly in the vicinities of Cincinnati, Ohio, and Louisville, Ky. The rises that occurred at a number of stations from 7 a. m. of January 14 until the crest was reached were as follows: Parkersburg, W. Va., 33.5 feet; Portsmouth, Ohio, 36.2 feet; Cincinnati, Ohio, 37.8 feet; Louisville, Ky., 37.6 feet; and Evansville, Ind., 15.6 feet.

On January 25 the "fuse plug levees" of the Birds Point-New Madrid floodway on the Missouri side of the Mississippi River just below Cairo, Ill., were opened allowing the water to spread out over a 130,000 acre floodway. The operation of this floodway is discussed in further detail in the Cairo, Ill., district report appearing at the end of this article. The effect of the spreading of the water over the floodway is seen in the fact that the river at Cairo, Ill., fell from 58.6 feet on the afternoon of the 25th to 57.9 feet on the morning of the 28th and then resumed a slower rise until the crest of 59.6 feet was reached on February 3–4. The rate of rise decreased materially upstream as far as Paducah, Ky.

The decrease in the rise in the lower portion of the river was also affected by a breaking through of the Ohio River to the watershed of the Cache River, which normally empties into the Ohio a few miles upstream from Cairo, Ill.

However, the Cache River overflowed the lowlands and the flow cut across southern Alexander County in Illinois and entered the Mississippi River 10 or 12 miles northwest of Cairo, Ill. This course is said by historians to have been an abandoned valley of the Ohio River. The features of this overflow are discussed in more detail in the Evansville, Ind., district report at the end of this article.

LOWER MISSISSIPPI DRAINAGE

The stages in the upper Mississippi River were quite low during the month of January and the Missouri River was unusually low as has been stated elsewhere in this report. The highest stage at St. Louis, Mo. (flood stage 30 feet) during January occurred on the 17th, when 12.8 feet was reached, then the stage dropped quickly to 7.7 feet on the 22nd and 7.0 on February 1. The river did not rise above the high point of January until February 25, when the stage at St. Louis, Mo., reached 18.8 feet.

The two largest western tributaries of the Mississippi River below Cairo, Ill., the Arkansas and the Red Rivers, drain a region which had been suffering from drought for the last three seasons and consequently did not contribute excessive water to the flood. The Poteau and the Petit Jean, tributaries of the Arkansas River, were slightly above flood stage in January. The Arkansas River proper reached flood stage only at Van Buren, Ark., on one day during January. The highest stage reached at Little Rock, Ark., was 18.8 feet on January 18, about 4 feet below flood stage, and the stage dropped to 11.2 feet on February 1. The river rose again to 17.6 feet on February 3 but fell quickly to 7.5 on the 10th. All of the tributaries of the Red River were mostly in light to moderate flood during much of January except the Ouachita River, which was in high flood with the highest stage at Camden, Ark., on January 25, reaching 41.5 feet, which is 0.5 foot

higher than in April 1927. The Red River proper, however, only exceeded flood stage by 1 foot at Alexandria, La., on February 2. The highest stage reached in the Red River at Shreveport, La., was 23.2 feet (flood stage 39 feet) on January 29. On February 10 the stage had fallen to 16.3 feet and on February 19 to 10.7 feet.

In the White Basin the Black River was only in moderate flood and in the White River flood stages were not exceeded above Calico Rock, Ark. The crest reached at Georgetown, Ark., was 30.3 feet on January 24–25, which is the same as in April 1927, but the levees held this time and not in 1927.

Of the remaining tributaries of the lower Mississippi River the St. Francis and the Yazoo Rivers had considerable flooding which began early in January in the upper portion and continued into March in the lower portions, the flooding during the latter period being due to backwater from the Mississippi River.

At the beginning of the rise in the Ohio River late in December the stages in the Mississippi River below Cairo, Ill., were very low. The stage at Memphis, Tenn., on December 31, was 9.2 feet and at New Orleans, La., 2.6 feet.

The prevailing low stages along the lower Mississippi River at the time of the beginning of the flood in the Ohio River, together with the low stages in the Mississippi River above Cairo, Ill., and the fact that the western tributaries of the lower Mississippi River did not at any time discharge more than moderately high amounts, and at the time of the crest in the Mississippi River their discharges had dropped off, all helped to prevent a super flood in the Mississippi River.

As it was, all previous records were broken from the mouth of the Ohio River to Helena, Ark., and at Natchez, Miss. Table 2 shows the height of the crest and the date, as well as the previous highest stages, along the lower Mississippi River.

TABLE 2.—*Highest stages reached along the lower Mississippi River in 1937 in comparison to the previous highest stages of record*

Station	Flood stage	Crest and date	Previous highest and year	Height of crest above	
				Flood stage	Previous highest
New Madrid, Mo.	34	47.9—Feb. 2-5	44.6—1913	13.9	3.3
Memphis, Tenn.	34	48.7—Feb. 10		14.7	
Beale Street gage	35	50.3—Feb. 10	46.6—1913	15.3	3.7
Helena, Ark.	44	60.3—Feb. 11	56.8—1927	16.3	3.5
Arkansas City, Ark.	42	53.8—Feb. 12-15	60.4—1927	11.8	
Greenville, Miss.	36	52.2—Feb. 15	54.7—1927	16.2	
Vicksburg, Miss.	43	53.2—Feb. 21	58.6—1927	10.2	
Natchez, Miss.	46	58.0—Feb. 21-25	56.6—1927	12.0	1.4
Baton Rouge, La.	35	45.0—Feb. 28	47.8—1927	10.0	
New Orleans, La.	17	19.3—Feb. 28	21.3—1922	2.3	

Flood stage was first exceeded on the lower Mississippi River on January 13 at New Madrid, Mo., and the last station to pass flood stage was New Orleans, La., on February 7. The first date that the river fell below flood stage at any point was on February 26 at New Madrid, Mo., and the last point to fall below flood stage was at Baton Rouge, La., on March 23.

With the exception of Natchez, Miss., the crests in the river below Helena, Ark., were below the peaks reached in 1927. The high stage reached at Natchez, Miss., is undoubtedly due to the action of the 12 cut-offs in the Mississippi River between the mouths of the Arkansas and Red Rivers, which helped to lower the stages in the upper portions of the region affected by hastening the progress of the water but in so doing piled up the water in the lower portion and at Natchez, Miss., which is 2 miles below the last cut-off.

Although the stages below Natchez, Miss., were 1.0 to 2.8 feet below the 1927 stages, the crest on the Atchafalaya River at Simmesport, La., was 4.1 feet lower than the 1927 crest. The cause of this discrepancy has been explained in the New Orleans, La., district report appearing at the end of this article.

The Bonnet Carre spillway located 23 miles upstream from New Orleans, La., was opened by the United States Engineers late in January, diverting a portion of the water from the river into Lake Ponchartrain. The resultant lowering of the stage at New Orleans, La., is estimated to be not less than 3 feet.

LOSS AND DAMAGE

It is impossible to give even an estimate of the amount of loss and damage that occurred in the Ohio and lower Mississippi Valleys at this time. The hardest hit of the larger cities probably was Louisville, Ky., where nearly 70 percent of the city was under water and about 175,000 people were forced to leave their homes. Jeffersonville, Ind., across the river was 90 percent inundated and 13,000 people fled from their homes. In the Evansville, Ind., district about 90,000 people were forced from their homes. Cincinnati, Ohio, because of its higher elevation, was probably more fortunate in that only 10 percent of its area was covered by water. However, the city was practically paralyzed by loss of water, power, heat, and light and nearly helpless to combat fires that broke out.

There were a number of smaller cities along the lower Ohio River that were completely submerged. The whole city of Paducah, Ky., with a population of between 30,000 and 40,000, was evacuated. Complete information of the extent of the inundation in the flooded area is not available at this time.

The city of Portsmouth, Ohio, was protected by a 60-foot wall which safely withheld the flood of March 1936. However, in the present flood the height of the water exceeded the top of the wall by more than 14 feet. As soon as it became apparent that the river stage would exceed the top of the wall, action was taken to permit the water to enter the city through openings in order to minimize the force of the current flowing over the wall. However, the rise in the river was so rapid that this action was only partially successful and considerable damage occurred from water rushing over the wall. Cairo, Ill., on the other hand, was safe behind its 60-foot wall as the crest of the river went up to 59.6 feet.

The extreme upper portion of the Ohio River, which was so hard hit in March 1936 escaped the worst part of this flood. At Pittsburgh, Pa., the damage was not great although the flood stage was exceeded by 9.5 feet. The losses increased in amount proceeding downstream.

The damage along the lower Mississippi River was confined almost entirely to the overflow between the banks and the levees and in the backwater areas of the tributaries. Because of the time of the year the losses of actual and prospective crops were not great. The levee system improved and constructed after the disastrous flood of 1927 withstood the exceptionally high stages remarkably well and no levee breaks occurred unless the overflow at the Bessie Landing cut-off in Tennessee can be considered as a levee break.

DISTRICT REPORTS

OHIO RIVER AND TRIBUTARIES AT AND ABOVE DAM NO. 13

By W. S. BROTZMAN

Over the Pittsburgh River district the month of January 1937 was characterized by mild weather with little snow and freezing temperature, and with frequent and unusually heavy rainfall. The rainfall for the month as a whole was greater than that of any other winter month with the exception of a narrow belt in the extreme eastern portion of the district where rainfall was excessive in March 1936.

The frequent rains kept the ground in a thoroughly saturated condition, and in addition furnished sufficient water to produce a rapid and heavy run-off. The water courses were running bankful from the 15th to near the end of the month, and were in flood in portions of the district almost continuously from the 18th to the 28th.

While the upper reaches of the rivers were in flood or near flood, generally, the flooding and damage was most extensive over the lower portion of the basin, between Pittsburgh and Dam No. 13, McMechen, W. Va. The Allegheny River rose considerably above flood stage between Lock No. 8, near Mosgrove, Pa., and Pittsburgh, Pa., but there was only slight damage, due largely to the fact that damageable property had been removed to safety. The Monongahela River was only slightly above flood stage and no damage was done.

At Pittsburgh, Pa., the river rose to 9.5 feet above the damage stage, but damage was remarkably slight. Warnings of the probable crest stages were issued in ample time to permit all possible precaution, thus limiting the principal losses to the suspension of business and cleaning up after the water receded. The local executive of the Red Cross reported that there were a few houseboats lost, but that they had no calls for rehabilitation as a result of the flood.

OHIO RIVER AND SOUTHERN TRIBUTARIES FROM BELOW DAM NO. 13 TO AND INCLUDING POINT PLEASANT, W. VA.

By R. P. POWELL

The January 1937 flood was the second highest flood of record in the central and lower parts of the district. Flood stage was first reached in the lower end of the district on the morning of the 17th. To understand this better, a review of conditions since the 14th is necessary.

On the 14th the Ohio River was about 18 feet under flood stage in the upper part of the district, 14 feet in the central, and only 9 feet in the lower. This was due to the heavy rains that had fallen over the entire watershed on the 10th and 11th and had partially run off thereby leaving the lower part of the district at a comparatively higher stage than the upper. These comparatively high stages were then fed by heavy rain over the Muskingum, the central and lower Ohio Valleys, and moderately heavy rains over the Little and the Great Kanawha, and upper Ohio Valleys on the night and morning of the 15th. This caused the tributaries to rise at all points.

Then, on the night and morning of the 18th heavy rains fell over the entire watershed and caused all the tributaries to start rising again. On the morning of the 19th, the heavy rains over the immediate valley had failed to fill in the differences in the stages of the upper and lower parts of the district, the lower parts still remaining, roughly, 10 to 15 feet higher.

Heavy rains occurred over the Great Kanawha watershed on the night of the 19th and 20th, causing the Great Kanawha River to rise rapidly and moderately heavy to heavy rains over the entire watershed on the 20th and the 21st caused all the tributaries to rise rapidly. Heavy rains again occurred over the lower Ohio and the Little Kanawha Valleys, and moderate rains over the remainder of the watershed on the afternoon of the 22d and the morning of the 23d.

On the morning of the 24th the Ohio River had become stationary to within 30 miles of Parkersburg, W. Va., the Muskingum River was falling as far down as Beverly, Ohio, and the Ohio River was rising very slowly at Parkersburg with a stage of 50.6 feet. Heavy rain beginning at 5 a. m. of the 24th over the central and northern parts of the district caused a secondary rise in the Little Kanawha, Muskingum, and upper Ohio Rivers.

No reports were received on the morning of the 25th because the Western Union wires were inundated, so that the forecasts were based on rainfall reports by radio and by telephone and by the action of the river. A few reports were received from the Pittsburgh, Pa., district on the morning of the 26th.

The Ohio River became stationary at Marietta, Ohio, and Parkersburg, W. Va., the afternoon and evening of the 26th, with a crest of 55.0 feet at Marietta and 55.4 feet at Parkersburg. Communication was still impossible with the lower parts of the district, but it was later determined that the crest at Point Pleasant, W. Va., was 62.7 feet on the morning of the 27th.

Communication was most difficult from the 24th until the 29th, but with the cooperation of the telephone company we were able to use whatever lines they had at any time. For instance, some calls made to Marietta, Ohio, 14 miles distant, were routed through Clarksburg, W. Va., Pittsburgh, Pa., Columbus, Ohio, and thence to Marietta, Ohio. So that about 400 miles of wire was used to complete these calls.

OHIO RIVER AND SOUTHERN TRIBUTARIES FROM AND INCLUDING THE MOUTH OF THE KANAWHA, TO AND INCLUDING THE MOUTH OF THE LITTLE KENTUCKY; THE NORTHERN TRIBUTARIES OF THE OHIO FROM DAM NO. 31 TO A POINT OPPOSITE THE MOUTH OF THE LITTLE KENTUCKY

By W. C. DEVEREAUX

The rainfall over the Cincinnati district, and especially along the Ohio River, during the period from January 7–25, 1937, was far in excess of any previous rainfall in this region for a period of 3 weeks or even for a full month. This caused the highest river stages of record at all the stations on the Ohio River from Dam No. 26 to Dam No. 39 and below to the mouth of the river.

The rainfall up to January 13 had been only moderately heavy in this district, and of sufficient amount to fill the river but not to the flood stage. Even the heavy rains on January 14–15 only filled the low places in the river above Cincinnati, and the river at Cincinnati fell 2 feet from the 15th to the 17th.

However, heavy and excessive rains started again on the 17th and continued for 9 days. As all the land surface was saturated with water and all the rivers and streams were bankful, the excessive rainfall ran directly into the river and caused rises as much as 0.4 foot in 1 hour and 6.9 feet in 24 hours at stages above 60 feet. The flood stage was first reached in the lower portion of the river on January 8, and then progressed slowly up the river, reaching Dam No. 38, in the lower part of the Cincinnati district, on January 15, Cincinnati on January 18 and Dam No. 26, in the upper part of the district, on January 19.

As the river was rising so fast and conditions so threatening additional river gages were established by surveys to provide for all possible stage heights. This precaution was taken as a matter of convenience for reading the Broadway gage, but proved most fortunate as both the Broadway gage and the recording gage at the West End Power Plant were flooded at a stage of 72 feet. Special observers read the gages each hour and reported to the Weather Bureau Office within 10 minutes after the hour for a period of 14 days. These readings were made to the hundredth of a foot. The two sets of readings gave most valuable records of stage heights not only for current use but for permanent record of the extreme stages.

The forecasts and warnings were made and fully distributed at frequent intervals. The probable crests were determined for each period when it seemed that the rains might cease, but when heavy rains started again the warning was to keep property 4 feet above the water surface as long as the river continued to rise rapidly, and then gradually decrease this margin as the crest was approached.

Every effort was made to give all reports the widest possible distribution and this phase of the service was very successful. The teletype service from the airport was moved to the Observatory, and gave great assistance in collecting weather reports. The United States Engineers collected river and weather reports, and greatly assisted in the distribution of reports. Electric power, gas, and telephone services were furnished the Weather Bureau when most other industries and residences were cut off, as this was necessary for the protection of lives and property. The weather maps and river bulletins were printed each day in the Weather Bureau Office and also in the Times Star. The hourly bulletins were broadcast by the four regular broadcasting stations and by five special stations set up for that purpose.

The Ohio River in the Cincinnati district was at a higher stage than ever before recorded. The record is fairly complete for 147 years. The excess over previous years increased from 1.6 feet at Dam No. 26 in the upper part of the district to 8.9 feet at Cincinnati and to 9.4 feet at Dam No. 39, the last station in the district.

The tributary streams in the Cincinnati district were in flood only in their lower portions and some of these streams up the valley were not even in flood. The Kentucky River was in superflood for 117 miles up the river, with highest stages of record at Frankfort

and High Bridge, Ky., but flood stages were not reached in the upper part of the river. The Big Miami was in flood below Hamilton, Ohio; the Whitewater and Little Miami were in flood, but flood stages were not reached in the Big Sandy Valley.

OHIO RIVER AND TRIBUTARIES FROM MOUTH OF THE KENTUCKY TO AND INCLUDING HAWESVILLE, KY.

By J. L. KENDALL

The flood developed in three parts or phases. The first was caused by the rains of the 9th to 15th, and crested at Louisville, Ky., on the 17th with a stage of 30 feet, upper gage, and 59 feet, lower gage.

Rain began to fall on this crest on the 17th and continued almost daily until the 23d, producing the second phase of the flood. During this period amounts of precipitation at representative stations were as follows: Louisville, Ky., 9.13 inches; Madison, Ind., 8.35 inches; Frankfort, Ky., 8.88 inches; High Bridge, Ky., 7.53 inches; Dam No. 43, Evans Landing, Ind., 8.91 inches; Dam No. 44, Leavenworth, Ind., 11.40 inches; Dam No. 45, Addison, Ky., 10.15 inches. This section of the flood rainfall ended with a freeze that held back about 0.60 inch of water in the form of snow and sleet. During this phase the flood passed the previous high watermark of February 15, 1884, 46.7 feet, and entered a new region for which there were no comparisons and no experience whatever. The historic record was passed by the rapidly rising stream at 12:30 p. m., January 22. At that time the river was rising at the rate of two-tenths foot per hour.

A crest near 52 feet, upper gage at Louisville, had been forecasted, and the flood showed indications of ending around that stage, when it entered its third phase with the heavy rain of Sunday, January 24. This rain fell on the accumulation of snow and ice, which acted much like a house roof in hastening its progress toward the river. Also, the water held back by the snow and sleet ran into the river with the rain, augmenting its effect. This rain, ranging from 2.00 to 4.00 inches in this district and falling with a high intensity, carried the river to its final crest of 72.7 feet at Madison, Ind., on the 26th, and 57.1 feet, upper gage at Louisville, on the 27th. The lower gage at Louisville was submerged at about 80 feet.

Aside from the entrance of this flood into 10 feet of altitude for which there is no comparison in the records, it had other peculiarities. The precipitation, while not continuous, was so closely grouped that no crest appeared nearer than the extreme upper river after the crest of 30 feet at Louisville on the 17th. This crest did not reach the lower river, where the rise was continuous. Because the heaviest rainfall occurred near the stream, the river filled rapidly from the sides, much like a ditch. Therefore, the flood became, to a marked degree, a rise in which the expected increase had to be computed directly from run-off, with less than the usual reference to gage relations. As with floods of this type, in about 48 hours after the rain ceased the crest was reached.

Another important feature was the tremendous output of the Kentucky River, which exaggerated the height of the water at Madison, Ind., and Louisville, Ky., with relation to stations upstream. The Kentucky River continued at a stage above 40 feet at Frankfort, Ky., for 6 days, and above 30 feet at High Bridge, Ky., for 7 days; although the upper course did not reach flood levels. The crest at Frankfort, Ky., 47.2 feet on the 25th, and 42.2 feet at High Bridge, Ky., on the 23d, are the highest ever known at those stations.

A third interesting feature was the effect of the enormous expansion of the river in the upper 5 feet on the relations with upstream gages. At the crest the river and its backwater at Louisville were 20 to 25 miles wide. This tremendous spread for a few feet of rise used up great quantities of water from up river, and reduced to a marked degree the percentage of stage increase. This was expected and partly provided for in the final estimates, but some allowance was made for a slightly higher stage than this expansion would indicate, so that no one would be caught by a crest set too low. It is estimated that this expansion reduced the probable crest at Louisville by 1.5 feet, if the usual gage relations had held.

In the last phase of the flood the river began to overflow its upper flood plain. Along the Ohio River in this district there are often two well defined flood plains, an upper on which the cities are built and a lower occupied by farm lands. At Louisville, Ky., Jeffersonville, Ind., and New Albany, Ind., these two plains merge more or less gradually into one another. At the crest the lower flood plain was covered, and only the tops of terraces on the upper plain were out of the water. Six more feet of water would have left very little of the upper flood plain protruding in the region of the three Falls Cities.

Strong currents seeking old channels across the flood plain developed in the upper levels of the flood. One of these ran down Broadway, Louisville, with such force that a boat could not be held against it. Another through the heart of Jeffersonville, Ind., caused much damage by battering buildings with drift. Erosion that was quite serious in places resulted from these currents. Some high building lots with a gravel base in Howard Park, a suburb of Jeffersonville, Ind., and also the Pennsylvania fill in the rear of the Colgate plant, were eroded away. The river did not run at such levels long enough to cut new channels.

Louisville was flooded to the extent of about 70 percent, and about 175,000 people were evacuated. Jeffersonville, Ind., was 90 percent flooded, and 13,000 people were forced from their homes. Several thousand people took refuge in Fort Fulton, Ind., an eastern suburb, located on a terrace with a few squares out of water. The water was 4 feet deep in the Quartermaster's Depot, which was at first a refuge but later had to be abandoned. New Albany, Ind., was about half covered, West Point, Ky., was nearly all destroyed. Leavenworth, Ind., was partly washed away. Hawesville, Ky.; Cloverport, Ky.; Cannellton, Ind.; and Tell City, Ind., were almost completely inundated.

In the latter part of the second phase of the flood, the regular telegraph and telephone communications with the section of the district below Louisville broke down. While receiving sets in that section continued to work, they obtained advice through WHAS and WAVE, the local radio stations. Crystal sets and battery sets were called into use when the electric power gave out. Amateur stations in Jeffersonville, Ind., were of service after that city had been surrounded by water and mostly overflowed. The local radio stations cooperated faithfully until driven off the air by the failure of the riverside plant of the Louisville Gas & Electric Co. at 11:35 p. m., Sunday, January 24.

At WHAS emergency power was obtained after a short interval, from the line to Dix Dam, and the service went on until the end. At the last this valuable assistant was the only agency through which this office could hope to reach the lower portion of the district. Too much cannot be said in commendation of the personnel of the radio stations, who worked to exhaustion in their efforts to broadcast flood information, calls for assistance, names of refugees, etc.

Upper gage estimates for Louisville, broadcast by radio, served well for all sections below to Tell City, Ind., when the reports from the dams could not be obtained. The people of that section have long been accustomed to the use of the upper gage at Louisville as a guide in estimating their own local flood conditions. The broadcasting of the hourly readings and estimates in terms of the upper gage gave them the information with which they were most familiar.

In the final stage of the flood, when Louisville was two-thirds under water, newspapers could not be published in the city from lack of power. Cards, carrying the forecasts and river stage, were tied to lamp posts by members of the Weather Bureau force, aided by Boy Scouts, on the island that constituted the heart of Louisville. This service continued until the Post Office again began to function. For several days the Federal Building, in which the Post Office is located, was surrounded by water. The Washington Building, in which the Weather Bureau Office is located, happens to be on one of the high spots in downtown Louisville. It is also within a few doors of the Western Union telegraph office. The "life line" of communication through the Western Union held during the flood, enabling the Weather Bureau to keep functioning. The Western Union maintained its service by moving the transformers from the basement to the upper floor and installing tractor engines to produce power. All basements contained water, and were usually one-half to two-thirds full. Fires could not be maintained except by heavy pumping, which had a tendency to carry the sand from under the floors of buildings, allowing them to collapse. For this reason, the pumps had to be stopped in places. One of the dramatic features of the flood was the continual beat of the pumps, going night and day, in the futile attempt to keep the water out of basements. At the Weather Bureau Office heat, light, power, water, and elevator service failed. These were not fully restored until February 18.

The Western Union sent a mobile unit to Jeffersonville, Ind., very quickly after communication with that place was cut off. Through Indianapolis and Cincinnati the operators of this unit were able to obtain the river stages and forecasts throughout the final stages of the flood. This unit was also able to supply New Albany, Ind., with flood information. The work of this unit was extremely valuable in preventing panic in those two cities.

When the water reached the telephone cables in the basement of the Washington Building, cutting off the Weather Bureau Office from the outside, the telephone company ran a special line in a few hours and restored service. Therefore, it was only for a few hours that this office could not be reached by telephone. During that time messenger service was used.

River stages and flood information was obtained early in the morning by teletype. The Weather Bureau men along the river strove in every way possible to get the vital information to each other.

OHIO RIVER AND TRIBUTARIES FROM BELOW HAWESVILLE, KY., TO THE MOUTH OF, BUT NOT INCLUDING, THE WABASH

By J. C. HAGAN

The 1937 flood actually saw its beginning the latter part of December 1936, when moderate to heavy rains began to fall over the entire Ohio River watershed. Moderate rises resulted over the entire Evansville district, with Evansville and Dam No. 47, Newburgh, Ind., being the first to pass flood stage, on January 10. Rains grew in intensity after the 10th, and soon all stations in the Evansville district were above flood stage.

With the 9th and 10th of January, there came a disaster, preceding a final and greater disaster, in the form of a glaze storm, destroying power and telephone lines, and halting traffic, caused by fallen trees and other debris. With an approaching flood, this condition was doubly serious, telephone lines to most of the key points along the river having been destroyed. Some of these stations were not heard from again until late in February.

Rains began again on the 14th, and continued for several days, resulting in the tentative stage forecast being raised from day to day; however, the forecast was always issued several days in advance of the stage. With the heavy rains of the 20th and 21st, tentative stages were forecast approximating the 1913 crests. Additional heavy rains on the 22d and 23d forced a new revision, with stages about 3 feet over the 1913 crests of the Ohio, and much higher stages than the previous extremes in the Green and Barren Rivers.

January 24 was the darkest day in the history of the Evansville Weather Bureau Office, started off with a complete absence of reports, causing the official in charge, McLin S. Collom, further worry, when he was already exhausted from an almost continuous grind since the 20th. Shortly before 11 a. m., Mr. Collom suffered a fatal stroke, succumbing at 11 a. m.

Stage reports, from upstream, began to arrive shortly after noon of the 24th, some of them having been 6 hours in transmission. At 4 p. m., using the meager reports available, a tentative stage forecast was issued for Evansville, as well as for other points in the district, for the latter part of the week. This forecast was given to the press and radio. Radio carried the burden of getting it across to the people, as practically all telephone and telegraph communication had been destroyed. Heavy rains continued until the morning of the 25th so that several slight revisions in the stage forecasts had to be made before a final forecast was arrived at. * * *.

A second rise started at Cincinnati, Ohio, on February 10, with a total rise of 14.1 feet in 4 days; started at Louisville on the 11th, with a total rise of 9.9 feet in 4 days. It was not indicated that this rise would affect the Evansville district materially (stage had already receded to about 40.0 feet at Evansville). However, a rise of 1 to 2 feet occurred in the upper district, but from Owensboro, Ky., to Evansville, Ind., the rise was slight, while below Evansville the falling tendency was decreased. This continued fall is believed to be caused by the reason set forth in the following paragraphs.

The flood plain of the Ohio River begins to widen at Tell City, Ind., about 75 miles upstream from Evansville by river, and attains a width of about 25 miles near Evansville. The flood plain continues wide downstream to Uniontown, Ky.; below Uniontown, it begins to narrow again and at Carrsville, Ky., 80 miles below Evansville, a bottle neck is formed by the foothills of the Ozarks, which run across Illinois. This condition is general from Carrsville to well below Paducah, Ky., and valves the water to such an extent as to cause a "lake" to be formed in the lower Evansville and upper Cairo districts.

This valving, or damming effect, of the hills forced the water high enough to affect towns and cities, which had never had water before, some were 25 to 30 miles inland.

About January 25 a condition developed at Golconda, Ill., which is believed to have saved the "lake" section from a considerable higher stage; this was the breaking through of the Ohio River to the watershed of Cache River, which normally empties into the Ohio River a few miles upstream from Cairo, Ill. In this case, however, the Cache River overflowed the lowlands in the vicinity of Hodges Park, Ill., and emptied into the flood plain of the Mississippi River. This way, additional thousands of second-feet were permitted to pass Golconda, Ill., relieving the water faster from the "lake" area.

Further proof of the effectiveness of this break was shown in the continued fall of the river at Dams Nos. 49 and 50, following the 14-foot secondary rise at Cincinnati on February 10.

The histories of southern Illinois (Lansden's History of Cairo) state that at one time the Cache River was the original bed of the Ohio River; the channel, at this time, running west from Golconda, Ill., to the Mississippi River, about 15 miles upstream from Cairo, Ill. This section was visited and all indications are that this condition once prevailed. At that time, the history relates, the Cumberland River flowed into the Tennessee River at Paducah, Ky., and followed the present course of the Ohio River to the Mississippi at Cairo, Ill.

From inquiry and personal observation in the Cache River section, an idea as to the volume of water that flowed through that section was obtained. On United States Highway 45, about midway between Vienna and Metropolis, Ill., it was noted that the water flowed over the highway at a depth of about 5 feet for more than a mile; the current in this particular section was described by natives as being too swift to navigate by boat, and that the condition did not last just a day, but continued for practically the entire duration of the flow through that section.

There is no doubt but that the Cache River cut-off lowered the stages in the Evansville district materially and resulted in a much faster run-off for the entire district, especially the Uniontown, Ky., area.

The cutting of the "fuse plug levees" in Missouri, just below Cairo, Ill., is also believed to have aided the lower Evansville district slightly, by permitting a more rapid flow.

One of the features of the flood at Evansville was the arrival of the Green River crest in the Ohio River, which could be seen in the action of the various gages. The crest of the Green River (mouth of Green is 6.5 miles below Dam No. 47) arrived just a few hours short of the Ohio crest, but in time to combine before they traveled past Evansville. On January 30, at 7 a. m. the river was falling at Dam No. 46 and had been stationary at Dam No. 47 for the past 12 hours. At 6 p. m., January 30, the river had again become stationary at Dam No. 46 and was rising at Dam No. 47. The crest of the Green River flowed into the Ohio late the afternoon of the 31st.

All means of transportation into Evansville were hampered by the water at its crest. Only one highway remained open, and it was covered with 1 foot of water. Another highway, State 66, was opened after many hours of placing sandbags and pumping by W.P.A. workers. The only railroad running, the Chicago and Eastern Illinois, had 17 inches of water over the track for a stretch of about a mile. This stretch was watched over by several hundred workers to keep it open. The airport was closed with 18 inches of water.

Most of the public utilities in the district were flooded out, adding further to the inconvenience of the people. Evansville, Ind.; Owensboro, Ky.; Mt. Vernon, Ind.; and Henderson, Ky., were able to maintain most of their utilities and so were major relief points for the district. A long hard battle was fought by the workers of water and power plants to maintain service.

Approximately a quarter of a million people were affected directly by the flood in the Evansville district (both Ohio and Green Rivers), of this number 90,360 were forced to evacuate their homes. A total of 22,040 homes were inundated in this district.

Three hundred and sixty-seven thousand acres of land were inundated in the Evansville district (Ohio and Green Rivers). Floods in the past have proven to be of benefit to the fertility of the lowlands, and did so in this case with sediment deposits of as much as 12 inches, but the value received on some lands was offset by the accumulation of sand in other sections.

Hundreds of acres were covered with sand, ranging from 1 to 8 feet in depth, entirely too deep for turning under. The heaviest deposits of sand are in Knight Township, Vanderburg County, upstream from United States Highway 41–S. The farmers are in hope that the next flood will leave a sufficient sediment deposit to reclaim this land.

The loss from prospective crops was very low, due to winter appearance of the flood. Only wheat and barley were affected to any extent. The wheat showed a return to life, following the recession of the water, but the barley was practically destroyed.

WABASH RIVER AND TRIBUTARIES

By J. H. ARMINGTON

The January flood in this district was "built up" by four successive periods of heavy rainfall, extending (nearly) over the 7th to 10th, 13th to 15th, 17th to 18th, and 20th to 25th; these following a period of moderately heavy rainfall during the latter part of December 1936, which caused flood stages at some points, and saturated the surface soil so that run-off was high with the first period of January rain.

No deep snow cover preceded this flood, as was the case in January 1930, and the moderate cover of 1 to 4 inches on December 19 had disappeared entirely by the 25th of that month. Nor was the cold spell of January 22 of sufficient severity to cause ice damage of consequence, as it did the former case, but the cold did add materially to the discomfort of those in the areas that were evacuated—chiefly the main White and extreme lower Wabash River sections. Also, this cold spell caused snow instead of rain on the 22d and 23d in the middle of the fourth precipitation period. The water content, ranging from about one-third inch over the upper West Fork

to nearly 1 inch over the East Fork, was released more slowly by melting during the following week, probably reducing somewhat the crests following, particularly in the East Fork and main White Valleys.

As was true through the entire State, there was a decided increase in the intensity of the rainfall in each of the four periods from north to south over the Wabash-White Basin. In the middle and upper Wabash Valley these amounts totalled well under previous January records at all stations; in the West Fork of White Valley the amounts were for the most part somewhat above previous January records; and over the East Fork of White Valley, the rainfall far exceeded that of any previous January at all stations.

The result of this distribution of rainfall was to produce a series of rises in the middle and upper channels of the Wabash and West Fork of White River, with the main crests occurring comparatively early, from the 16th at Bluffton, Ind., on the Wabash River, to the 19th at Edwardsport, Ind., on West Fork of White River; while the descending water from above and the heavier rainfall below caused a more continuous rise in the East Fork and main White, and the extreme lower Wabash River, to their crests later. At Williams and Shoals, Ind., on the East Eork, the crests occurred on January 25. Below, from Petersburg, Ind., on the White, to New Harmony, Ind., on the Wabash, crests were somewhat earlier—January 21 to January 24—most probably because of the serious breaking of levees in the Decker and Hazleton, Ind., sections. At New Harmony, Ind., on the Wabash River, about 50 miles above confluence with the Ohio, while the crest from upstream water was reached on January 24 and there was a slight fall on the following 2 days, a further rise occurred due to backing water from the Ohio River, the final crest being recorded on January 31.

Advices and warnings were issued frequently during the period to all river and distributing stations, and further distribution, was secured by the two Indianapolis radio stations WIRE and WKBF, and the radio station at Evansville, Ind., WGBF. The several State Police radio stations also assisted materially, not only in distributing the advices issued, but also in gathering data and reporting conditions from areas in which wire communication was interrupted. On numerous occasions the Indianapolis radio stations, particularly WIRE, interrupted their regular programs to send out information and warnings sent out by this office. It was necessary also in securing prompt distribution and in getting information for the Weather Bureau office at Indianapolis to call persons by long distance telephone; and calls by telephone from all parts of the river district were frequent throughout the flood period. * * *

At Decker, Ind., the old gage used by the Weather Bureau until the installation of the gages at Hazleton and Petersburg, Ind., showed the crest of the flood at that place to be 30 feet on January 21. It is 1 foot higher than any crest previously observed (29.0 feet in January 1930) and exceeded by 1.2 feet the crest of the flood of March 1913. There is no doubt, therefore, that the White River in this flood of January 1937 experienced the highest water of record along its whole course. This is further borne out by the excessive flooding in the Hazleton, Ind., area, which necessitated the evacuation of many families and damaged considerably the approaches to the highway bridge on Road No. 41, and did some damage to the bridge itself.

It will be noticed that, while the flood in the main White was without doubt higher than any previously known flood, the stages in the Wabash below at Mount Carmel, Ill., were 4 feet below the 31.0 crest of March 1913. This is due to the fact that there was not so much water upstream in the Wabash channel in this year's flood, as well as to the breaking of levees on the White, which slowed down the rush of water from that stream into the Wabash River.

Damage and loss were very severe in the White section below junction of the forks, and in the extreme lower Wabash stretches, but were only moderate to light in the middle and upper channels of the basin.

CUMBERLAND RIVER AND TRIBUTARIES

By R. M. WILLIAMSON

Heavy rainfall over the Cumberland River Basin during the night of January 1 averaged approximately 2.50 inches; several stations reported in excess of 4.00 inches. This occurred on a rising river bringing an immediate flood at Celina, Tenn., before 7 a. m. and flood warnings were issued at 8:30 a. m., January 2, for all points from Burnside, Ky., to Nashville, Tenn.

The damage from this flood was comparatively light. However, a second flood was in progress shortly after the middle of the month, much more serious than the first.

The actual crests reached in this second flood are given in the table below for a number of points, and comparison is made with the previous high records. The rank as to highest will drop to fourth place for Celina, Tenn., and third place for Carthage, Tenn., if the flood of January 1882 (which occurred before these stations were established) is considered.

Station	Length of record (years)	Crest January 1937	Rank as to highest on record	Previous record	Year
Burnside, Ky.	53	54.3		69.4	1929
Celina, Tenn.	34	53.6	Third	[1] 57.1	1926
Carthage, Tenn.	52	54.6	Second	[2] 58.7	1926
Nashville, Tenn.	63	53.8	Third	56.2	1927
Clarksville, Tenn.	36	65.5	First	[3] 60.0	1927
Eddyville, Ky.	20	76.9	do.	68.5	1927

[1] 57.5, January 1882.
[2] 56.5, January 1882.
[3] 60.6, January 1882.

OHIO RIVER BELOW THE MOUTH OF THE WABASH; MISSISSIPPI RIVER FROM AND INCLUDING CAPE GIRARDEAU, MO., TO AND INCLUDING NEW MADRID, MO.; TENNESSEE RIVER AND TRIBUTARIES BELOW DECATUR, ALA.

By W. E. BARRON

After several months of comparatively low water, in which some unusually low stages were reached, a general rise began in the Ohio River during the last week of December 1936 and developed within 1 month's time into the greatest flood of record.

The flood was caused almost entirely by excessive rains over the drainage area of the Ohio River and its tributaries, including the three largest, the Wabash, the Cumberland, and the Tennessee Rivers. There was practically no snow on the ground at the beginning of the month and whatever amounts fell subsequently were absorbed in the general rains or floods, and had no particular influence on the stages of the river.

The table shows successively the amount of precipitation at various reporting stations for the periods January 1–10, 11–18, 19–25, together with the totals for the 25 days.

Table showing precipitation in inches by periods: January 1–25, 1937, for selected stations, Cincinnati, Ohio, to New Madrid, Mo. (Daily measurements, 7 a. m. or 8 a. m., seventy-fifth meridian time.)

Station	Jan. 1–10	Jan. 11–18	Jan. 19–25	Total, 25 days
Cincinnati, Ohio	1.70	4.56	7.25	13.51
Louisville, Ky.	3.38	4.94	10.30	18.62
Evansville, Ind.	1.90	5.07	7.34	14.31
Dam No. 48	1.81	5.70	7.81	15.32
Dam No. 49	2.89	5.96	8.43	17.28
Shawneetown, Ill.	3.38	6.36	9.20	18.94
Dam No. 50	3.53	4.00	9.71	17.24
Dam No. 51	3.88	4.53	9.99	18.40
Paducah, Ky.	3.76	2.75	10.64	17.15
Dam No. 52	4.48	3.68	10.87	19.03
Dam No. 53	3.66	5.38	8.55	17.59
Cairo, Ill.	3.33	3.87	7.91	15.11
New Madrid, Mo.	2.82	2.30	8.34	13.46

Rain periods along the Cumberland and Tennessee Rivers coincided roughly with those along the Ohio River. The Cumberland River reached 45.3 feet at Nashville, Tenn., on January 8, then receded to 24.0 feet on January 13, after which the almost daily rains brought the stage to 53.8 feet on January 26. This was an important contributing factor to the flood of the lower Ohio.

Along the Tennessee River the rainfall from December 30, 1936, to January 3, 1937, was 5.60 inches at Chattanooga, Tenn.; 5.73 inches at Guntersville, Ala.; 3.92 inches at Decatur, Ala.; 3.64 inches at Florence, Ala.; 3.07 inches at Riverton, Ala.; 5.44 inches at Savannah, Tenn.; and 1.70 inches at Johnsonville, Tenn. At the same time there were equally as heavy rains on the Elk River, which flows into the Tennessee a few miles above Wheeler Dam, and on the Duck River, which joins the Tennessee 14 miles above Johnsonville, Tenn. The rains and upriver discharges produced 33.0 feet at Chattanooga, Tenn., on January 4; 32 feet at Guntersville, Ala., and 23.2 feet at Decatur, Ala., on January 7; 19.6 feet at Florence, Ala., on January 6; 40.3 feet at Riverton, Ala., on January 7; 40.1 feet at Savannah, Tenn., and 32.0 feet at Johnsonville, Tenn., on January 8. Subsequent rains from January 9 to 25, inclusive, were as follows: Chattanooga, 5.76 inches; Guntersville, 7.50 inches; Decatur, 7.76 inches; Florence, 7.32 inches; Riverton, 5.60 inches; Savannah, 8.55 inches; Johnsonville, 21.97 inches, These rains were so distributed in point of time as to produce two

crests at Chattanooga, 28.5 feet on January 20; 26.8 feet on January 27; and two also at Guntersville, 28.0 feet on January 22, and 28.5 feet on January 28. At Decatur, located in the reservoir of Wheeler Dam, the stage was maintained at or above 17 feet until February 6, with a second peak of 23.9 feet on January 25. Resulting crests at the stations in the Cairo district were: 19.2 feet at Florence on January 26; 40.9 feet at Riverton on January 27; 42.2 feet at Savannah on January 27 and 28; and 41.0 feet at Johnsonville on January 25. The last named was much influenced by backwater from the Ohio River at Paducah, Ky. These crests were considerably under previous records. They were probably reduced to some extent by storage in the reservoirs in the upper portion of the Tennessee River.

After the Missouri floodway went into operation, the river at Cairo fell from 58.6 feet on the afternoon of the 25th to 57.9 feet on the morning of the 28th, and then resumed rising at a slower rate as a result of the greater spread of water, a condition which had been anticipated and forecast. The rate of rise decreased materially as far upstream as Paducah, Ky. This decrease was aided by the overbank flooding of the Cache River Basin. Water from the Ohio River backed up Big Bay Creek, whose outlet is 8 miles below Dam No. 51, overtopped the ridge separating it from the Cache Valley, and followed the course of the latter across the northern portions of Massac and Pulaski Counties in Illinois, then cutting across southern Alexander County, entered the Mississippi River some 10 or 12 miles northwest of Cairo. This course is said by historians to have been an abandoned valley of the Ohio River; at that time the united Cumberland and Tennessee Rivers followed the present course of the Ohio from Paducah to Cairo. A range of low hills separates the two basins.

For the three periods shown in the table the average daily precipitation at Cincinnati, Ohio, was 0.17 inch for the first period; 0.57 inch for the second period; 1.04 inches for the third period; at Louisville, Ky., 0.34 inch for the first period; 0.62 inch for the second period; 1.47 inches for the third period; from Evansville, Ind., to Dam No. 49, 0.22 inch for the first period; 0.70 inch for the second period; 1.12 inches for the third period; from Dam No. 50 to Paducah, Ky., 0.37 inch for the first period; 0.47 inch for the second period; 1.44 inches for the third period; from Dam No. 52 to Cairo, Ill., 0.38 inch for the first period; 0.54 inch for the second period; 1.39 inches for the third period.

It will be seen that the precipitation for the last period was considerably heavier than the two preceding periods combined. The daily rate of rise in the river therefore was much greater in the last period, January 19 to 24, than in the preceding period, January 11–18, inclusive: Evansville, Ind., 1.1 as compared to 1.0; Dam No. 48, 1.3 as compared to 1.1; Dam No. 49, 2.1 as compared to 1.1; Dam No. 50, 2.2 as compared to 1.2; Dam No. 51, 1.9 as compared to 1.0; Paducah, Ky. (United States Reservation gage), 1.9 as compared to 0.7; Dam No. 52, 1.8 as compared to 0.7; Dam No. 53, 1.6 as compared to 0.8; Cairo, Ill., 1.5 as compared to 0.9 foot.

Counting from December 30, 1936, the total amounts of rise to the crests, Evansville to Cairo, were as follows: 39.55 feet at Evansville; 43.6 feet at Dam No. 48; 48.9 feet at Dam No. 49; 51.6 feet at Dam No. 50; 46.0 feet at Dam No. 51; 46.6 feet at Dam No. 52; 43.2 feet at Cairo. This interesting bulge from dam no. 49 to Dam No. 50 was due largely to a constriction in the river extending from the mouth of the Saline River in Illinois to below Golconda, Ill., a distance of about 40 miles, through which the river must pass between high hills varying from 1 to 2 miles apart; these hills being an extension of the Ozark uplift. It was in part due to the water from the Wabash River, which reached a crest of 27.0 feet at Mount Carmel, Ill., on January 23, its rise having been stopped short of the expected crest by the breaking of levees along the White River in Indiana, some 20 miles above its mouth near Mount Carmel, Ill.

At the beginning of the rise counting also from December 30, stages were very low in the Mississippi River below Cairo: 8.5 feet at Memphis, Tenn., and 2.6 feet at New Orleans, La. Such a condition produces a rapid current and ordinarily tends to lower the stages reached from Paducah, Ky., to Cairo Ill. The States west of the Mississippi River, drained by the Missouri, White, Arkansas, and Red Rivers had been suffering from drought for the last three seasons, and contributed no water to produce a super flood.

MISSISSIPPI RIVER FROM BELOW NEW MADRID, MO.; TO THE MOUTH OF THE WHITE; ST. FRANCIS RIVER AND TRIBUTARIES

By F. W. BRIST

The record-breaking flood of January and February 1937, from Dam No. 26 to Cairo, Ill., on the Ohio River, and from Cairo, Ill., to Natchez, Miss., on the Mississippi River, was inaugurated by heavy rains attending an energetic area of low-barometric pressure central over Kansas City, Mo., on the morning of December 31. On this date a steady rise began in the Ohio River from Parkersburg, W. Va., to Cairo, Ill., which was uninterrupted at Evansville, Ind., and points below and only briefly at Cincinnati, Ohio, until the crest stages of the flood were reached.

* * * * *

The crest stages reached in the Memphis district were as follows: Memphis, 48.7 feet on the self-recording gage and 50.3 feet on the Beale Street gage, in use by the Weather Bureau in previous high floods, February 10; Helena, Ark., 60.3, February 11.

The crest stage at Memphis was 3.7 feet higher than the highest previous flood, which occurred in 1913, and 4.3 feet higher than the flood of 1927. At Helena, Ark., the crest was 3.5 feet higher than the previous highest flood, which occurred in 1927.

No breaks occurred in the Mississippi levees in this district below the Bessie, Tenn., cut-off and the damage was confined to the overflow between the banks and the levees and in the backwater areas of the lower St. Francis Basin in Arkansas and the tributaries of western Tennessee.

The river at Memphis was above the flood stage, 35 feet on the Beale Street gage, from January 21 to March 1, inclusive, or a total of 40 days. It was above 40 feet from January 24 to February 25, or 33 days. It was thus continuously above a stage of 40 feet during a longer period than in any flood beginning with 1903, except that of 1922, when it was 45 days. At Helena, Ark., it was above 50 feet from January 26 to March 1, or 35 days, being a longer period than that of any flood beginning with 1903, except in 1922 and 1927, when it was 44 days.

The cut-off at Bessie, Tenn., whereby an undetermined but increasing amount of water flowed across a narrow neck of land in a loop of the river, and the delayed flow of water through the Cairo spillway added about 0.67 foot more to the crest at Memphis than was apparently indicated by the combined waters of the upper Mississippi and the Ohio Rivers.

MISSISSIPPI RIVER FROM THE MOUTH OF THE WHITE TO THE MOUTH OF THE BIG BLACK; YAZOO AND BIG BLACK RIVERS AND TRIBUTARIES

By R. T. LINDLEY

Including about 765,000 acres flooded by backwater from the Mississippi River, the total acreage overflowed during January and February in Delta counties of Mississippi, embracing the Black and the Sunflower-Tallahatchie-Yazoo Basins, amounted to about 1,533,700 acres. However, it is estimated that only about one-fifth of the area flooded was in cultivation, and the greater part only sparsely inhabited. Also, it should be borne in mind that agricultural activity was practically dormant at the time of this flood and the loss of actual and prospective crops was not great.

A large item of expense was incurred in the evacuation of the region, furnishing subsistence and quarters for the families during the continuance of the flood, and the loss of productive labor.

MISSISSIPPI RIVER BELOW THE MOUTH OF THE BIG BLACK; RED RIVER BELOW SHREVEPORT, LA.; OUACHITA AND BLACK RIVERS AND TRIBUTARIES IN LOUISIANA; ATCHAFALAYA RIVER

By W. F. MCDONALD

The Bonnet Carre spillway located 23 miles above New Orleans, La., was opened by the United States Engineers late in January, and at maximum discharged over 200,000 cubic feet per second from the river into Lake Pontchartrain. The lowering of the stage at Carrollton gage (New Orleans) is estimated to have been not less than 3 feet due to operation of the spillway.

* * * * *

The State and United States Engineers waged an intensive fight to hold levees. Their efforts were completely successful. Notwithstanding the fact that at Natchez, Miss., a new record stage almost 2 feet above previous records was experienced, there was no levee failure. The Natchez crest stands out as the only instance on the Mississippi River below Helena, Ark., in which a new record stage was established. This local peak at Natchez was undoubtedly due to the action of the 12 cut-offs in the Mississippi River between the mouths of the Arkansas and Red Rivers, which operated to depress stages on the upper reaches affected but produced a new high record at Natchez. Below the latter point, crests on the Mississippi River were from 1.0 to 2.8 feet below the previous records established in 1927, while on the Atchafalaya, the crest was 4.1 feet below the previous record at Simmesport, La.

This pronounced discrepancy in the development of the crest in the Mississippi River at and below Angola, La., as compared with the Atchafalaya River, was due to the very fortunate circumstance that the backwater basin in Louisiana, lying to northward of the

mouth of the Red River and known as the Tensas Basin, was practically free of water prior to the overflow from the Mississippi River into this basin after the bankfull stage was reached at Angola.

The Red River experienced a moderate rise which only passed flood stage by 1 foot at Alexandria, La., and the Ouachita River also came into flood, reaching a crest 5 feet above flood stage at Monroe, La. There was, however, a notable absence of rain in northern Louisiana for about 3 weeks as the rise was developing in the Mississippi River, and as a consequence of this fact, together with the low floods in the Red and Ouachita Rivers, the Tensas Basin escaped with a maximum stage of only 55.8 feet at Jonesville, La., which was 8.3 feet below the record established in 1927 at that place.

The improvement of levee systems and particularly the construction of guide levees through the Atchafalaya Basin raised stages in the open basin above Morgan City, La., and a new high record was established at Atchafalaya, La., where confinement of the discharge produced a crest of 25.9 feet, which is 1.0 foot above the previous (1932) record at that station and 1.3 feet above the 1927 crest.

COLORADO DRAINAGE

Heavy rains during the first week in February occurring over the snow covered watersheds of the tributaries of the Colorado River in Arizona caused several of these tributaries to overflow their banks. A bridge was washed downstream on the Williams River and partially wrecked a pontoon bridge at Parker, Ariz., with losses amounting to about $18,000. The Verde and Salt Rivers were also in flood with $25,000 to $30,000 damage at the Bartlett Dam site on the Verde River. The Gila River was slightly above flood stage on February 8 at Kelvin, Ariz.

SAN JOAQUIN DRAINAGE

Two winter freshets occurred in the Kings River and also in the Kaweah, Tule, and Kern Rivers to the south of the Kings basin. The Kings River was in flood on February 6 and 7 and again on the 13th and 14th, as shown by the gaging station at Piedra, Calif. (The Weather Bureau has no gaging stations on the other streams.) The largest item of loss occasioned by these floods was the damage to roads and bridges amounting to about $367,000. Reports on other items are not complete.

A rather wet January over that section with extremely low temperatures prevailing resulted in the accumulation of an unusually deep snow cover at low levels in the Sierra Nevada foothills. Much of this snow cover was carried off by heavy, warm rains on February 6 and again on February 14. The following item of interest was reported by the official in charge at Fresno, Calif.:

Reports on the extent of inundated areas are not available at this time. Of these, a large part are reclaimed portions of the Tulare Lake basin, where 24 sections of grain were flooded and Summit Lake, also reclaimed and devoted to fruit and general farming. These areas are natural sinks where the floodwaters of the Kings, Tule, and Kaweah Rivers find their way. In extreme high water, as in the February floods, water from the Kern River also reaches the Tulare Lake basin. In years of average or less than average precipitation practically all of the water from these streams is diverted for irrigation and an attempt has been made to control moderate wastage in a few levied sections at the lowest part of the Tulare Lake basin and even that is planted to grain each year, although it is understood to be hazardous. The Summit Lake area also protected by levees has somewhat better protection and some deciduous fruits and grapes are planted. These basins have no drainage and seepage and evaporation must remove the water. It is believed that trees and vines in the Summit Lake basin will be killed and the inundated portion of the Tulare Lake basin may be kept out of production for 2 or more years.

A light flood occurred on February 7 and 8 in the lower reaches of the Mokelumne River, a tributary of the lower San Joaquin River. This was caused mainly by contributing streams in the lower portion of the Mokelumne as the water from the upper portion was going into storage at Pardee Dam. No damage of consequence occurred.

Table of flood stages during January–February 1937

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ST. LAWRENCE DRAINAGE					
Lake Erie	*Feet*			*Feet*	
St. Marys: Decatur, Ind.	13	Jan. 14	Jan. 26	20.1	Jan. 17.
St. Joseph:					
Montpelier, Ohio	10	Jan. 15	Jan. 17	11.2	Jan. 16.
Fort Wayne, Ind.	12	...do...	Jan. 18	13.1	Do.
Maumee:					
Napoleon, Ohio	10	Jan. 16	...do...	12.1	Jan. 17.
Fort Wayne, Ind.	15	Jan. 14	Jan. 19	17.8	Jan. 18.
Sandusky:					
Upper Sandusky, Ohio	13	Jan. 15	Jan. 16	15.0	Jan. 16.
		Jan. 22	Jan. 22	13.7	Jan. 22.
		Jan. 26	Jan. 26	14.7	Jan. 26.
Tiffin, Ohio	7	Jan. 16	Jan. 17	7.6	Jan. 16.
ATLANTIC SLOPE DRAINAGE					
Lackawaxen: Hawley, Pa.	9	Feb. 22	Feb. 22	9.7	Feb. 22.
Tioughnioga: Whitney Point, N. Y.	10	Jan. 15	Jan. 16	12.5	Jan. 15.
		Jan. 18	Jan. 27	12.9	Jan. 20.
		Feb. 21	Feb. 23	11.8	Feb. 22.
Chenango:					
Greene, N. Y.	8	Jan. 25	Jan. 26	9.5	Jan. 25.
Sherburne, N. Y.	8	...do...	...do...	9.2	Do.
Susquehanna:					
Oneonta, N. Y.	12	Jan. 22	Jan. 22	12.4	Jan. 22.
		Jan. 25	Jan. 27	14.6	Jan. 25.
Bainbridge, N. Y.	12	Jan. 26	Jan. 26	12.7	Jan. 26.
Potomac: Sycamore Island, Md.	10	Jan. 23	Jan. 24	10.4	Jan. 24.
		Feb. 23	Feb. 23	10.2	Feb. 23.
James:					
Buchanan, Va.	17	Jan. 21	Jan. 21	17.1	Jan. 21.
Columbia, Va.	10	Jan. 2	Jan. 7	23.9	Jan. 4.
		Jan. 18	Feb. 3	25.4	Jan. 21.
		Feb. 12	Feb. 12	10.2	Feb. 12.
		Feb. 21	Feb. 26	17.9	Feb. 23.
Richmond, Va.	8	Jan. 3	Jan. 5	13.1	Jan. 4.
		Jan. 20	Jan. 23	14.9	Jan. 22.
Dan:					
Danville, Va.	11	Jan. 3	Jan. 4	12.5	Jan. 4.
		Jan. 20	Jan. 20	11.0	Jan. 20.
Clarksville, Va.	13	Jan. 4	Jan. 6	14.8	Jan. 5.
		Jan. 21	Jan. 22	13.9	Jan. 22.
Roanoke:					
Randolph, Va.	21	Jan. 3	Jan. 5	26.4	Jan. 5.
		Jan. 19	Jan. 23	25.0	Jan. 22.
Weldon, N. C.	31	Jan. 3	Jan. 9	42.9	Jan. 7.
		Jan. 19	Jan. 25	42.0	Jan. 23.
Williamston, N. C.	10	Jan. 6	Feb. 18	14.0	Jan. 27.
		Feb. 26	Mar. 1	10.3	Feb. 28.
Fishing Creek: Enfield, N. C.	14	Jan. 30	Feb. 1	14.7	Jan. 30, 31.
Tar:					
Rocky Mount, N. C.	8	Jan. 4	Jan. 6	8.6	Jan. 6.
		Jan. 29	Feb. 1	10.9	Jan. 30.
Tarboro, N. C.	18	Jan. 30	Feb. 6	25.1	Feb. 2.
Greenville, N. C.	13	Jan. 7	Jan. 12	14.1	Jan. 10.
		Jan. 24	Jan. 26	13.0	Jan. 24–26.
		Jan. 29	Feb. 9	15.7	Feb. 3.
Little: Kenly, N. C.	8	Jan. 6	Jan. 9	9.4	Jan. 7.
		Jan. 28	Feb. 3	16.5	Jan. 31.
Neuse:					
Neuse, N. C.	14	Jan. 2	Jan. 9	17.0	Jan. 6.
		Jan. 19	Jan. 24	16.1	Jan. 23.
		Jan. 29	Feb. 1	15.7	Jan. 31.
Smithfield, N. C.	13	Jan. 3	Jan. 11	17.2	Jan. 7, 8.
		Jan. 20	Jan. 25	15.1	Jan. 25.
		Jan. 27	Feb. 4	19.2	Jan. 31.
		Feb. 23	Feb. 24	13.5	Feb. 24.
Goldsboro, N. C.	13	Jan. 6	Jan. 17	18.3	Jan. 13.
		Jan. 22	Feb. 19	24.1	Feb. 3.
		Feb. 25	(1)	14.1	Feb. 27.
Kinston, N. C.	13	Jan. 8	Jan. 20	16.3	Jan. 16.
		Jan. 25	Feb. 22	20.0	Feb. 6.
		Feb. 27	(1)		
Haw: Moncure, N. C.	20	Jan. 4	Jan. 4	20.6	Jan. 4.
		Jan. 21	Jan. 21	20.6	Jan. 21.
Cape Fear:					
Fayetteville, N. C.	35	Jan. 5	Jan. 5	35.4	Jan. 5.
		Jan. 22	Jan. 22	35.4	Jan. 22.
		Jan. 29	Jan. 31	39.5	Jan. 30.
Lock No. 2, Elizabethtown, N. C.	20	Jan. 2	Jan. 11	28.1	Jan. 5, 6.
		Jan. 19	Jan. 25	28.1	Jan. 22
		Jan. 27	Feb. 6	29.6	Jan. 31.
		Feb. 11	Feb. 13	21.3	Feb. 12.
		Feb. 22	Feb. 25	23.5	Feb. 23.
Peedee:					
Cheraw, S. C.	30	Jan. 3	Jan. 7	36.2	Jan. 5.
		Jan. 20	Jan. 23	36.6	Jan. 22.
		Jan. 30	Jan. 30	30.8	Jan. 30.
Mars Bluff Bridge, S. C.	17	Jan. 4	Feb. 19	21.9	Jan. 10.
		Feb. 24	(1)	17.6	Feb. 26, 27.
Poston, S. C.	18	Jan. 10	Jan. 21	21.7	Jan. 13.
		Jan. 23	Feb. 13	21.5	Jan. 29.
		Feb. 16	Feb. 19	18.6	Feb. 17, 18.
Saluda:					
Pelzer, S. C.	6	Dec. 31	Jan. 9	12.8	Jan. 3.
		Jan. 19	Jan. 24	8.5	Jan. 20.
		Jan. 30	Jan. 30	6.0	Jan. 30.
		Feb. 1	Feb. 1	6.3	Feb. 1.
		Feb. 9	Feb. 13	6.6	Feb. 10.
		Feb. 20	Feb. 24	6.5	Feb. 21.

See footnotes at end of table.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE—contd.					
	Feet			*Feet*	
Saluda—Continued.		Jan. 2	Jan. 8	22.1	Jan. 5.
Chappells, S. C	15	Jan. 21	Jan. 23	17.8	Jan. 22.
		Jan. 26	Jan. 27	16.7	Jan. 26.
		Feb. 10	Feb. 11	15.9	Feb. 11.
Broad: Blairs, S. C	14	Jan. 1	Jan. 7	21.9	Jan. 5.
		Jan. 20	Jan. 22	19.5	Jan. 22.
Congaree: Columbia, S. C	19	Jan. 5	Jan. 5	20.4	Jan. 5.
Catawba:					
Catawba, N. C	8	Jan. 3	Jan. 4	14.7	Jan. 3.
		Jan. 18	Jan. 21	15.7	Jan. 19.
Catawba, S. C	11	Jan. 3	Jan. 4	16.4	Jan. 4.
		Jan. 20	Jan. 21	16.0	Jan. 20.
Wateree: Camden, S. C	23	Jan. 4	Jan. 7	27.3	Jan. 4.
		Jan. 20	Jan. 23	27.0	Jan. 21.
Santee:					
Rimini, S. C	12	Dec. 31	(1)	18.8	Jan. 10.
Ferguson, S. C	12	Jan. 1	(1)	14.2	Jan. 10, 11.
Broad: Carlton, Ga	15	Jan. 2	Jan. 4	19.9	Jan. 3.
		Feb. 21	Feb. 21	15.0	Feb. 21.
Savannah:					
Ellenton, S. C	14	Jan. 2	Jan. 14	28.3	Jan. 6.
		Jan. 16	(1)	21.2	Feb. 13.
		Dec. 28	Jan. 2	14.6	Dec. 30.
Clyo, Ga	13	Jan. 8	Jan. 21	19.4	Jan. 11.
		Jan. 26	(1)	16.6	Feb. 18.
Ogeechee:					
Midville, Ga	6	Feb. 15	Feb. 15	6.2	Feb. 15.
		Feb. 4	Feb. 11	7.1	Feb. 7, 8.
Dover, Ga	7	Feb. 15	Feb. 16	7.0	Feb. 15, 16.
		Feb. 18	Feb. 23	7.7	Feb. 20.
Ocmulgee:					
Macon, Ga	18	Jan. 4	Jan. 7	19.9	Jan. 6.
		Jan. 9	Jan. 16	14.1	Jan. 12.
Abbeville, Ga	11	Feb. 2	Feb. 4	11.2	Feb. 3.
		Feb. 15	Feb. 19	12.3	Feb. 17.
		Feb. 27	(1)	11.8	Feb. 28.
Oconee: Milledgeville, Ga	22	Jan. 5	Jan. 7	26.0	Jan. 6.
		Feb. 10	Feb. 11	25.7	Feb. 10.
Altamaha:					
Charlotte, Ga	12	Jan. 12	Jan. 22	17.0	Jan. 17.
		Jan. 28	(1)	15.9	Feb. 22.
Everett City, Ga	10	Jan. 20	Jan. 24	10.4	Jan. 22.
		Feb. 10	Feb. 11	10.0	Feb. 10, 11.
		Feb. 22	(1)	10.8	Feb. 26.
EAST GULF OF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla	15	Jan. 4	Jan. 19	19.9	Jan. 10, 11.
		Jan. 21	(1,2)	19.5	Feb. 26.
Oostanaula:					
Resaca, Ga	22	Jan. 3	Jan. 7	26.5	Jan. 5.
Rome, Ga	25	Jan. 2	...do...	31.0	Jan. 4.
Etowah: Canton, Ga	17	...do...	Jan. 4	20.4	Jan. 3.
Coosa:					
Mayos Bar Lock, Ga	28	Jan. 3	Jan. 8	34.9	Jan. 4.
		Jan. 2	Jan. 12	26.5	Jan. 5–7.
Gadsden, Ala	20	Jan. 20	Jan. 23	21.2	Jan. 21.
		Jan. 25	Jan. 27	20.6	Jan. 27.
Lock No. 4, Lincoln, Ala	17	Jan. 2	Jan. 12	21.7	Jan. 3, 4.
		Jan. 20	Jan. 21	17.4	Jan. 20.
Cahaba: Centerville, Ala	23	Jan. 2	Jan. 4	26.6	Jan. 3.
		Jan. 19	Jan. 21	26.6	Jan. 20.
Alabama:		Jan. 25	Jan. 26	24.0	Jan. 26.
Montgomery, Ala	35	Jan. 5	Jan. 9	38.5	Jan. 7.
Millers Ferry, Ala	40	Jan. 6	Jan. 14	46.0	Jan. 10.
Black Warrior: Lock No. 10, Tuscaloosa, Ala	46	Jan. 3	Jan. 6	58.7	Jan. 3.
		Jan. 19	Jan. 22	51.6	Jan. 20.
		Jan. 25	Jan. 28	53.6	Jan. 26.
Tombigbee:					
Aberdeen, Miss	34	Jan. 24	Jan. 27	36.0	Jan. 25.
Lock No. 4, Demopolis, Ala	39	Jan. 3	Feb. 17	57.9	Feb. 1.
Lock No. 3	33	Jan. 2	(1,3)	57.9	Feb. 2.
Lock No. 2	46	Jan. 4	Feb. 17	59.1	Feb. 2, 3.
Lock No. 1	31	Jan. 5	(1)	40.2	Feb. 4–6.
Leaf: Hattiesburg, Miss	18	Jan. 21	Jan. 24	21.6	Jan. 22.
Chickasawhay:					
Enterprise, Miss	20	Jan. 6	Jan. 7	21.8	Jan. 6.
		Jan. 19	Jan. 23	27.9	Jan. 21.
		Jan. 25	Jan. 27	21.0	Jan. 27.
Shubuta, Miss	26	Jan. 6	Jan. 11	29.0	Jan. 8.
		Jan. 21	Jan. 31	34.3	Jan. 23.
Pascagoula: Merrill, Miss	22	Jan. 12	Jan. 13	22.1	Jan. 12.
		Jan. 24	Feb. 3	23.8	Jan. 26–29.
Bogue Chitto: Franklinton, La	12	Jan. 21	Jan. 22	16.1	Jan. 21.
Pearl:					
Edinburg, Miss	20	Jan. 22	Jan. 28	22.9	Jan. 24.
Jackson, Miss	18	Jan. 6	Feb. 12	30.0	Jan. 29.
		Feb. 25	(1)	20.9	Mar. 1.
Monticello, Miss	15	Jan. 6	Jan. 9	15.8	Jan. 8.
		Jan. 18	Feb. 11	21.7	Jan. 20.
Columbia, Miss	17	Jan. 20	...do...	22.5	Jan. 22.
Pearl River, La	12	Jan. 9	Feb. 20	16.0	Jan. 25.
		Feb. 26	(1)	12.8	Feb. 28.

See footnotes at end of table.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
	Feet			*Feet*	
Iowa: Wapello, Iowa	10	Feb. 22	Feb. 25	12.2	Feb. 24.
Skunk: Augusta, Iowa	15	Feb. 20	Feb. 23	17.2	Feb. 22.
Des Moines:					
Tracy, Iowa	14	Feb. 19	...do...	19.8	Feb. 21.
Ottumwa, Iowa	9	Feb. 20	Feb. 22	12.9	Do.
Illinois:					
Peru, Ill	17	Jan. 10	Jan. 12	17.4	Jan. 11.
		Feb. 21	Feb. 23	17.9	Feb. 22.
Havana, Ill	14	Jan. 11	Feb. 10	16.0	Jan. 24.
		Feb. 22	(1)	14.7	Feb. 26.
Beardstown, Ill	14	Jan. 13	Feb. 5	16.7	Jan. 22.
		Feb. 23	(1)	15.1	Feb. 27, 28.
Bourbeuse: Union, Mo	12	Jan. 17	Jan. 17	12.1	Jan. 17.
Meramec:					
Sullivan, Mo	11	Jan. 15	Jan. 16	14.0	Jan. 15.
Valley Park, Mo	14	Jan. 10	Jan. 10	14.2	Jan. 10.
		Jan. 15	Jan. 18	19.0	Jan. 17.
Mississippi: Keithsburg, Ill	12	Feb. 24	Feb. 26	12.3	Feb. 25.
Missouri Basin					
Grand:					
Gallatin, Mo	20	Feb. 13	Feb. 14	22.5	Feb. 14.
		Jan. 31	Jan. 31	20.4	Jan. 31.
Chillicothe, Mo	18	Feb. 13	Feb. 16	26.8	Feb. 14.
		Feb. 18	Feb. 23	27.2	Feb. 21.
Brunswick, Mo	12	Feb. 23	Feb. 24	12.5	Feb. 24.
Ohio Basin					
		Jan. 11	Jan. 11	8.5	Jan. 11.
Kiskiminetas: Saltsburg, Pa	8	Jan. 21	Jan. 23	11.0	Jan. 22.
		Jan. 25	Jan. 25	10.3	Jan. 25.
Allegheny:					
Franklin, Pa	17	...do...	Jan. 26	18.0	Do.
Parkers Landing, Pa	20	...do...	Jan. 25	21.2	Do.
Lock No. 8, near Mosgrove, Pa	24	Jan. 15	Jan. 16	25.9	Jan. 15.
		Jan. 21	Jan. 27	31.2	Jan. 25.
Lock No. 5, near Schenley, Pa	24	Jan. 15	Jan. 17	26.4	Jan. 16.
		Jan. 18	Jan. 19	25.3	Jan. 19.
		Jan. 21	Jan. 27	34.2	Jan. 25.
Lock No. 4, Natrona, Pa	24	Jan. 15	Jan. 16	24.9	Jan. 16.
		Jan. 21	Jan. 23	30.1	Jan. 22.
		Jan. 25	Jan. 27	31.6	Jan. 25.
Lock No. 3, Acmetonia, Pa	25	Jan. 21	Jan. 24	30.9	Jan. 22.
		Jan. 24	Jan. 27	32.8	Jan. 25.
Monongahela:					
Lock No. 7, Greensboro, Pa	30	Jan. 23	Jan. 23	30.9	Jan. 23.
		Jan. 25	Jan. 25	30.1	Jan. 25.
Lock No. 4, Charleroi, Pa	30	...do...	...do...	30.0	Do.
Walhonding: Walhonding, Ohio	8	Jan. 15	Jan. 28	16.9	Jan. 15.
Tuscarawas:					
Newcomerstown, Ohio	16	Jan. 17	Jan. 18	17.4	Jan. 17.
		Jan. 22	Jan. 28	20.6	Jan. 26.
Coshocton, Ohio	11	Jan. 15	Jan. 30	23.3	Do.
Muskingum:					
Lock No. 10, Zanesville, Ohio	25	Jan. 16	Jan. 16	26.0	Jan. 16.
		Jan. 18	Jan. 29	37.6	Jan. 26.
Lock No. 7, McConnelsville, Ohio	22	Jan. 15	Jan. 30	36.0	Do.
Lock No. 3, Lowell, Ohio	25	Jan. 18	...do...	(7)	
Lock No. 1, Marietta, Ohio	35	...do...	...do...	55.0	Do.
Little Kanawha:					
Glenville, W. Va	23	Jan. 23	Jan. 23	25.1	Jan. 23.
Creston, W. Va	20	...do...	Jan. 25	22.8	Do.
Hocking: Athens, Ohio	17	Jan. 15	Jan. 16	18.6	Jan. 16.
		Jan. 21	Jan. 27	22.4	Jan. 23.
Olentangy: Delaware, Ohio	9	Jan. 14	Jan. 16	13.1	Jan. 15.
		Jan. 18	Jan. 18	9.0	Jan. 18.
		Jan. 21	Jan. 23	11.6	Jan. 22.
		Jan. 25	Jan. 26	12.0	Jan. 25.
Scioto:		Jan. 14	Jan. 16	13.9	Jan. 15.
La Rue, Ohio	11	Jan. 18	Jan. 19	12.2	Jan. 18.
		Jan. 21	Jan. 23	13.9	Jan. 21.
		Jan. 24	Jan. 26	13.0	Jan. 25.
Prospect, Ohio	10	Jan. 15	Jan. 28	13.3	Jan. 23.
Chillicothe, Ohio	16	...do...	...do...	27.9	Do.
Little Miami: Kings Mills, Ohio	17	Jan. 14	Jan. 15	21.0	Jan. 15.
		Jan. 18	Jan. 18	19.8	Jan. 18.
		Jan. 21	Jan. 23	24.8	Jan. 22.
		Jan. 24	Jan. 25	24.8	Jan. 25.
South Fork of Licking: Cynthiana, Ky	20	Jan. 22	Jan. 22	20.0	Jan. 22.
Licking:					
Farmers, Ky	25	Jan. 23	Jan. 25	26.0	Jan. 25.
Falmouth, Ky	28	Jan. 11	Jan. 11	28.2	Jan. 11.
		Jan. 21	Jan. 27	42.0	Jan. 23.
Stillwater: Pleasant Hill, Ohio	13	Jan. 14	Jan. 16	17.5	Jan. 15.
		Jan. 21	Jan. 22	13.5	Jan. 21.
Mad: Springfield, Ohio	11	Jan. 14	Jan. 15	11.2	Jan. 14.
		Jan. 21	Jan. 21	13.2	Jan. 21.
		Jan. 25	Jan. 25	14.1	Jan. 25.
Whitewater: Brookville, Ind	20	Jan. 14	Jan. 15	22.8	Jan. 15.
		Jan. 21	Jan. 21	22.5	Jan. 21.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
Miami:	*Feet*			*Feet*	
Franklin, Ohio	16	Jan. 22	Jan. 22	16.7	Jan. 22.
Middletown, Ohio	15	Jan. 15	Jan. 17 [9]	16.7	Jan. 16.
		Jan. 17	Jan. 19	15.8	Jan. 18.
		Jan. 21	Jan. 24 [8]	17.5	Jan. 22.
		Jan. 24	Jan. 26	15.8	Jan. 26.
Hamilton, Ohio	17	Jan. 21	Jan. 22	17.3	Jan. 22.
Kentucky:					
Lock No. 10, Ford, Ky	30	Jan. 23	Jan. 23	30.6	Jan. 23.
		Jan. 25	Jan. 25	30.1	Jan. 25.
Lock No. 7, Highbridge, Ky	30	Jan. 18	Jan. 19	34.1	Jan. 18.
		Jan. 21	Jan. 27	42.2	Jan. 23.
Lock No. 4, Frankfort, Ky	31	Jan. 18	Jan. 29	47.2	Jan. 25.
Barren: Bowling Green, Ky	20	Jan. 17	...do...	40.7	Jan. 23.
Green:					
Lock No. 6, Brownsville, Ky	28	...do...	Jan. 30	54.7	Jan. 24.
Lock No. 4, Woodbury, Ky	33	Jan. 11	Feb. 4	59.0	Do.
Lock No. 2, Rumsey, Ky	34	...do...	Feb. 24	54.4	Jan. 30, 31.
West Fork of White:					
Anderson, Ind	8	Dec. 30	Jan. 5	10.0	Jan. 1.
		Jan. 8	Feb. 25	18.6	Jan. 15.
Noblesville, Ind	14	Jan. 14	Jan. 17	18.8	Jan. 16.
Indianapolis, Ind	12	...do...	...do...	16.8	Do.
Elliston, Ind	18	Dec. 31	Jan. 4	21.2	Jan. 3.
		Jan. 8	Feb. 4	30.2	Jan. 17.
		Feb. 10	Feb. 12	20.0	Feb. 11.
Edwardsport, Ind	12	Jan. 1	Feb. 7	20.8	Jan. 18, 19.
		Feb. 9	Feb. 18	17.3	Feb. 13.
		Feb. 21	Feb. 27	15.4	Feb. 25.
East Fork of White:					
Seymour, Ind	14	Jan. 9	Jan. 12	15.6	Jan. 11.
		Jan. 14	Jan. 28	19.4	Jan. 16.
Williams, Ind	10	...do...	Feb. 2	25.0	Jan. 25.
Shoals, Ind	25	Jan. 15	...do...	37.2	Do.
White:					
Petersburg, Ind	16	Jan. 10	Feb. 9	28.1	Jan. 21.
		Feb. 13	Feb. 16	17.3	Feb. 15.
Hazleton, Ind	16	Jan. 10	Feb. 17	31.6	Jan. 22.
Wabash:					
Bluffton, Ind	10	Jan. 14	Jan. 19	14.9	Jan. 16.
La Fayette, Ind	11	Dec. 31	Jan. 4	15.2	Jan. 1, 2.
		Jan. 8	Jan. 27	21.2	Jan. 17.
		Feb. 1	Feb. 3	13.4	Feb. 2.
		Feb. 9	Feb. 11	12.7	Feb. 10.
		Feb. 21	Feb. 24	14.6	Feb. 23.
Covington, Ind	16	Jan. 1	Jan. 4	18.6	Jan. 3.
		Jan. 8	Jan. 26	25.3	Jan. 18.
		Feb. 2	Feb. 3	16.4	Feb. 3.
		Feb. 22	Feb. 24	17.8	Feb. 24.
Terre Haute, Ind	14	Jan. 2	Jan. 6	14.7	Jan. 4, 5.
		Jan. 8	Jan. 29	21.3	Jan. 16.
		Feb. 1	Feb. 4	14.3	Feb. 1–3.
		Feb. 24	Feb. 25	14.1	Feb. 24, 25.
Vincennes, Ind	14	Jan. 12	Feb. 4	22.8	Jan. 22.
Mount Carmel, Ill	19	Jan. 13	Feb. 9	27.0	Jan. 23.
New Harmony, Ind	15	Jan. 14	Feb. 14	24.4	Jan. 30, 31.
New: New River, Tenn	18	Jan. 2	Jan. 3	26.6	Jan. 2.
		Jan. 25	Jan. 25	22.4	Jan. 25.
		Feb. 9	Feb. 9	21.8	Feb. 9.
Cumberland:					
Williamsburg, Ky	19	Jan. 2	Jan. 4	22.2	Jan. 3.
		Jan. 18	Jan. 21	21.1	Jan. 19.
		Jan. 25	Jan. 27	22.1	Jan. 26.
		Feb. 10	Feb. 10	19.3	Feb. 10.
Burnside, Ky	50	Jan. 3	Jan. 3	54.3	Jan. 3.
Lock No. 21, Eadsville, Ky	48	Jan. 3	Jan. 4	51.7	Do.
		Jan. 19	Jan. 19	49.1	Jan. 19.
Celina, Tenn	28	Jan. 2	Jan. 8	43.7	Jan. 6.
		Jan. 16	Feb. 1	53.6	Jan. 24.
		Feb. 11	Feb. 13	30.8	Feb. 12.
Carthage, Tenn	40	Jan. 3	Jan. 8	47.6	Jan. 4.
		Jan. 18	Feb. 1	54.6	Jan. 26.
		Jan. 2	Jan. 10	52.9	Jan. 5.
Lock No. 6, Hartsville, Tenn	35	Jan. 16	Feb. 3	60.8	Jan. 27.
		Feb. 11	Feb. 13	36.0	Feb. 12.
Lock No. 3, Hendersonville, Tenn	45	Jan. 3	Jan. 10	50.7	Jan. 7.
		Jan. 18	Feb. 3	59.1	Jan. 28, 29.
Nashville, Tenn	40	Jan. 3	Jan. 11	45.3	Jan. 8.
		Jan. 18	Feb. 4	53.8	Jan. 26.
Lock A, Neptune, Tenn	40	Jan. 4	Jan. 11	43.8	Jan. 9.
		Jan. 17	Feb. 5	56.0	Jan. 25.
Clarksville, Tenn	46	Jan. 5	Jan. 12	49.7	Jan. 11.
		Jan. 17	Feb. 6	65.5	Jan. 25.
Lock F, Eddyville, Ky	50	Jan. 6	Feb. 19	57.9	Jan. 13.
				76.9	Jan. 26.
North Fork of Holston: Mendota, Va	8	Jan. 21	Jan. 21	8.3	Jan. 21
		Feb. 9	Feb. 10	8.7	Feb. 9.
Pigeon: Newport Tenn	6	Jan. 2	Jan. 4	11.7	Jan. 3.
French Broad:					
Asheville, N. C	6	Jan. 1	Jan. 6	8.3	Do.
		Jan. 20	Jan. 21	6.5	Jan. 20.
Oldtown (near Newport, Tenn.)	6	Jan. 1	Jan. 5	11.4	Jan. 3.
		Jan. 19	Jan. 22	7.7	Jan. 20.
Dandridge, Tenn	12	Jan. 3	Jan. 4	15.4	Jan. 3.
Little Tennessee: McGhee, Tenn	18	...do...	...do...	20.4	Do.
Clinch: Clinton, Tenn	25	Feb. 17	Feb. 18	25.9	Feb. 18.

See footnotes at end of table.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Ohio Basin—Continued					
	Feet			*Feet*	
Elk: Fayetteville, Tenn	14	Jan. 2	Jan. 5	21.2	Jan. 3.
		Jan. 20	Jan. 20	15.2	Jan. 20.
		Feb. 9	Feb. 9	14.9	Feb. 9.
Duck: Columbia, Tenn	32	Jan. 2	Jan. 5	38.5	Jan. 3.
Tennessee:					
Chattanooga, Tenn	30	Jan. 3	Jan. 6	33.0	Jan. 4.
		Jan. 2	Jan. 7	23.7	Jan. 5.
Bridgeport, Ala	18	Jan. 19	Jan. 23	20.6	Jan. 21, 22.
		Jan. 26	Jan. 28	19.7	Jan. 27.
		Feb. 10	Feb. 13	19.5	Feb. 12.
Widows Bar Lock, Ala.:					
Upper gage	17	Jan. 2	Jan. 8	24.8	Jan. 5.
		Jan. 16	Jan. 29	21.9	Jan. 21.
		Feb. 10	Feb. 13	20.5	Feb. 12.
Lower gage	26	Jan. 2	Jan. 8	32.8	Jan. 5.
		Jan. 19	Jan. 23	29.4	Jan. 21.
		Jan. 26	Jan. 28	28.7	Jan. 27.
		Feb. 10	Feb. 13	27.6	Feb. 12.
Guntersville, Ala	25	Jan. 3	Jan. 9	32.0	Jan. 6, 7.
		Jan. 17	Jan. 30	28.5	Jan. 28.
		Feb. 11	Feb. 14	26.5	Feb. 13.
Decatur, Ala	20	Jan. 2	Jan. 11	23.2	Jan. 6-9.
		Jan. 16	Feb. 4	23.9	Jan 25, 26.
Florence, Ala	18	Jan. 3	Jan. 8	20.1	Jan. 4.
		Jan. 25	Jan. 28	19.2	Jan. 26.
		Jan. 3	Jan. 12	40.3	Jan. 7.
Riverton, Ala	33	Jan. 16	Feb. 1	40.9	Jan. 27.
		Feb. 14	Feb. 14	33.0	Feb. 14.
Savannah, Tenn	39	Jan. 6	Jan. 11	40.1	Jan. 8.
		Jan. 20	Feb. 1	42.2	Jan. 27, 28.
Johnsonville, Tenn	31	Jan. 6	Jan. 13	32.0	Jan. 8.
		Jan. 17	Feb. 9	41.0	Jan. 25.
Ohio:					
Pittsburgh, Pa	25	Jan. 18	Jan. 20	28.1	Jan. 19.
		Jan. 21	Jan. 27	34.5	Jan. 26.
Old Dam No. 2, Coraopolis, Pa	26	Jan. 22	Jan. 23	29.1	Jan. 23.
		Jan. 25	Jan. 27	31.1	Jan. 26.
Dam No. 7, Midland, Pa	30	Jan. 19	Jan. 20	32.5	Jan. 19.
		Jan. 21	Jan. 28	44.4	Jan. 26.
Dam No. 12, near Wheeling, W. Va	36	Jan. 22	...do...	48.7	Do.
Dam No. 13, near Wheeling, W. Va	45	...do...	...do...	52.0	Do.
Parkersburg, W. Va	36	Jan. 18	Jan. 31	55.4	Do.
Dam No. 19, Little Hocking, Ohio	40	Jan. 19	Jan 30	57.9	Jan. 26, 27.
Dam No. 20, near Belleville, W. Va	45	Jan. 22	...do...	59.1	Jan. 27.
Dam No. 22, Ravenswood, W. Va	44	Jan. 21	Jan. 31	60.5	Do.
Dam No. 25, near Addison, Ohio	43	Jan. 17	Feb. 1	66.6	Do.
Point Pleasant, W. Va	40	...do...	Feb. 2	62.7	Do.
Dam No. 26, near Hogsett, W. Va	50	Jan. 19	Feb. 1	70.3	Do.
Dam No. 28, Huntington, W. Va	50	...do...	Feb. 2	69.3	Do.
Dam No. 29, Ashland, Ky	51	Jan. 18	...do...	73.6	Do.
Dam No. 30, near Greenup, Ky	52	...do...	Feb. 3	74.7	Do.
Portsmouth, Ohio	50	...do...	...do...	74.1	Do.
Dam No. 32, near Vanceburg, Ky	53	...do...	...do...	75.5	Do.
Dam No. 33, near Maysville, Ky	50	...do...	Feb. 4	75.3	Do.
Dam No. 35, New Richmond, Ohio	48	...do...	...do...	75.1	Jan. 26.
Dam No. 36, near Brent, Ky	52	...do...	...do...	79.8	Do.
Cincinnati, Ohio	52	...do...	Feb. 5	80.0	Do.
Dam No. 37, Fernbank, Ohio	50	Jan. 15 [9]	...do...	78.8	Jan. 25, 26.
Dam No. 38, near Grant, Ky	51	...do [9]	...do...	78.6	Jan. 26.
Dam No. 39, Markland, Ind	48	Jan. 18	...do...	73.5	Do.
Madison, Ind	46	...do...	...do...	72.7	Do.
Dam No. 41, Louisville, Ky.:					
Upper Gage	28	Jan. 16	Feb. 7	57.1	Jan. 27.
Low-water Gage	51	...do...	...do...	81.4	Do.
Dam No. 43, Evans Landing, Ind	57	...do...	...do...	86.1	Do.
Dam No. 44, Leavenworth, Ind	53	Jan. 15	Feb. 8	84.2	Do.
Dam No. 45, Addison, Ky	47	...do...	...do...	69.4	Jan. 28.
Dam No. 46, Owensboro, Ky	41	Jan. 16	Feb. 10	54.8	Jan. 29, 30.
Dam No. 47, Newburgh, Ind	38	Jan. 10	Feb. 19	56.7	Jan. 31.
Evansville, Ind	35	...do...	...do...	53.8	Jan. 31—Feb. 1.
Dam No. 48, near Henderson, Ky	38	Jan. 12	...do...	58.8	Do.
					Do.
Dam No. 49, near Uniontown, Ky	37	Jan. 13	Feb. 22	64.8	Feb. 1, 2.
Shawneetown, Ill. [10]	33	Jan. 8 [6]	Feb. 23	65.5	Feb. 2.
Dam No. 50, Fords Ferry, Ky	34	...do...	Feb. 24	68.1	Feb. 1–3.
Dam No. 51, Golconda, Ill	40	Jan. 14	Feb. 22	62.6	Do.
Paducah, Ky. [11]	39	Jan. 10	...do...	60.6	Feb. 2.
Dam No. 52, Brookport, Ill	37	Jan. 8	Feb. 24	62.5	Feb. 2, 3.
Dam No. 53, near Mound City, Ill	42	...do...	Feb. 26	63.9	Do.
Cairo, Ill	40	Jan. 9	Feb. 27	59.6	Feb. 3, 4.
White Basin					
Black:					
Leeper, Mo	11	Jan. 15	Jan. 15	14.1	Jan. 15.
Williamsville, Mo	11	Jan. 14	...do...	14.2	Jan. 14, 15
Poplar Bluff, Mo	14	Jan. 9	Jan. 11	15.1	Jan. 10.
		Jan. 14	Jan. 18	17.6	Jan. 16.
Black Rock, Ark	14	Jan. 9	Feb. 16	26.2	Do.
		Feb. 21	Feb. 22	14.0	Feb. 21, 22.
White:					
Calico Rock, Ark	18	Jan. 14	Jan. 18	27.4	Jan. 15.
Batesville, Ark	23	...do...	Jan. 19	31.5	Do.
Newport, Ark	26	Jan. 15	Feb. 6	30.7	Jan. 18.
Georgetown, Ark	21	Jan. 11	Feb. 22 [12]	30.3	Jan. 24, 25.
Clarendon, Ark	26	Jan. 14	Mar. 9	35.7	Jan. 28, 29.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Arkansas Basin					
	Feet			*Feet*	
Poteau: Poteau, Okla.	21	Jan. 9	Jan. 13	26.6	Jan. 10.
		Jan. 13	Jan. 18	27.6	Jan. 16.
		Jan. 26	Jan. 27	21.4	Jan. 26.
Petit Jean: Danville, Ark.	20	Jan. 10	Jan. 19	23.6	Jan. 16.
Arkansas: Van Buren, Ark.	22	Jan. 22	Jan. 29	24.3	Jan. 23.
		Jan. 17	Jan. 17	22.0	Jan. 17.
Red Basin					
Ouachita:					
		Jan. 10	Jan. 12	21.9	Jan. 11.
Arkadelphia, Ark.	17	Jan. 15	Jan. 16	17.6	Jan. 15.
		Jan. 20	Jan. 26	26.0	Jan. 23.
Camden, Ark.	26	Jan. 11	Feb. 4	41.5	Jan. 25.
Monroe, La.	40	Jan. 31	Mar. 7	44.7	Feb. 9, 10.
Black: Jonesville, La.	50	Feb. 9	[13]	55.8	Mar. 4–7
Little: Whitecliffs, Ark.	25	Jan. 13	Jan. 18	25.4	Jan. 13, 14.
		Jan. 24	Jan. 27	26.4	Jan. 25.
Sulphur:					
		Jan. 8	Jan. 18	23.0	Jan. 15.
Ringo Crossing, Tex.	20	Jan. 22	Jan. 22	20.1	Jan. 22.
		Jan. 24	Jan. 28	23.5	Jan. 25.
Naples, Tex.	22	Jan. 2	Jan. 6	22.8	Jan. 4, 5.
		Jan. 13	Feb. 4	25.5	Jan. 21, 22.
Cypress: Jefferson, Tex.	18	Jan. 26	Jan. 30	19.4	Jan. 28.
Red: Alexandria, La.	32	Jan. 27	Feb. 5	33.0	Feb. 2.
Lower Mississippi Basin					
Big Lake Outlet: Manila, Ark.	10	Jan. 9	Mar. 6	21.4	Jan. 27, 28.
St. Francis:					
		Jan. 1	Jan. 5	23.4	Jan. 2.
		Jan. 8	Jan. 28	26.2	Jan. 15.
Fisk, Mo.	20	Jan. 31	Feb. 5	23.3	Feb. 3.
		Feb. 10	Feb. 12	21.9	Feb. 11.
St. Francis, Ark.	18	Jan. 5	Feb. 20	26.7	Jan. 19.
St. Francis Lake Lock, Ark.	30	Jan. 24	Feb. 2	31.1	Jan. 27, 28.
Marked Tree, Ark.	17	Jan. 26	Feb. 18	18.8	Feb. 5–9.
Parkin, Ark.	28	Jan. 22	Mar. 4	34.3	Feb. 4–6.
Madison, Ark.	32	...do...	Mar. 7	40.7	Feb. 13.
Tallahatchie: Swan Lake, Miss.	26	Jan. 7	Mar. 13	33.9	Feb. 2.
Yazoo:					
Greenwood, Miss.	35	Feb. 2	Feb. 16	36.4	Feb. 9.
Yazoo City, Miss.	29	Jan. 29	[13]	37.1	Feb. 24.
Mississippi:					
New Madrid, Mo.	34	Jan. 13	Feb. 26	47.9	Feb. 2–5.
Memphis, Tenn.	34	Jan. 20	Mar. 1	48.7	Feb. 10.
Helena, Ark.	44	Jan. 22	Mar. 6	60.3	Feb. 11.

Table of flood stages during January–February 1937—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Lower Mississippi Basin—Continued					
Mississippi—Continued.	*Feet*			*Feet*	
Arkansas City, Ark.	42	Jan. 27	Mar. 8	53.8	Feb. 12–15.
Greenville, Miss.	36	Jan. 24	...do...	52.2	Feb. 15.
Vicksburg, Miss.	43	Jan. 29	Mar. 15	53.2	Feb. 21.
Natchez, Miss.	46	Jan. 30	Mar. 18	58.0	Feb. 21–25
Angola, La.	45	Feb. 1	Mar. 22	55.5	Feb. 27, 28.
Baton Rouge, La.	35	Feb. 2	Mar. 23	45.0	Feb. 28.
Donaldsonville, La.	28	Feb. 3	Mar. 22	34.5	Feb. 27.
Reserve, La.	22	Feb. 5	Mar. 20	25.6	Feb. 26.
New Orleans, La.	17	Feb. 7	Mar. 19	19.3	Feb. 28.
Atchafalaya Basin					
Atchafalaya:					
Simmesport, La.	41	Feb. 6	Mar. 22	49.3	Mar. 1–4.
Melville, La.	37	Feb. 3	Mar. 24	44.8	Mar. 2, 3.
Atchafalaya, La.	22	Jan. 22	[11]	25.9	Mar. 7–9.
GULF OF CALIFORNIA DRAINAGE					
Colorado Basin					
Gila: Kelvin, Ariz.	5	Feb. 7	Feb. 8	6.2	Feb. 8.
PACIFIC SLOPE DRAINAGE					
San Joaquin Basin					
Kings: Piedra, Calif.	10	Feb. 6	Feb. 7	13.9	Feb. 6.
		Feb. 13	Feb. 14	13.7	Feb. 14.
Mokelumne: Bensons Ferry, Calif.	12	Feb. 7	Feb. 8	12.7	Feb. 7.

[1] Continued into March.
[2] Fell slightly below flood stage on Feb. 9.
[3] Fell slightly below flood stage on Feb. 20.
[4] Fell slightly below flood stage on Jan. 24.
[5] Gage could not be read on Jan. 16 due to high water.
[6] Estimated.
[7] Water over gage.
[8] Fell slightly below flood stage on Jan. 17 and 24.
[9] Fell slightly below flood stage on Jan. 17.
[10] Readings furnished by U. S. Engineer Office.
[11] Readings from U. S. Geological Survey recording gage.
[12] Fell slightly below flood stage on Feb. 21.
[13] Continued on Mar. 31.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL, in charge]

NORTH ATLANTIC OCEAN, FEBRUARY 1937

By H. C. HUNTER

Atmospheric pressure.—Pressure averaged lower than normal over nearly all the North Atlantic area. The greatest deficiency noted, about one-third of an inch, was found around and to the northeastward of the British Isles.

The deficiency was less, but considerable, toward the northwest, to Iceland, also toward the southwest, to the Azores. Slight excesses were indicated over the Gibraltar-Madeira section and from Newfoundland and southeastern Labrador northeastward to southern Greenland. On the American side the deficiency was moderately large, greater than a tenth of an inch, from the coasts of the Middle Atlantic States and southern New England to the vicinity of Bermuda.

In general, the North Atlantic HIGH was displaced to the southeastward of its normal position in February and remained so until quite near the end of the month.

The range of pressure was less than is usual during winter. For the highest marks there are several readings between 30.50 and 30.60 inches, chiefly from waters slightly to eastward of Hatteras, on the 11th or 12th, and from the vicinity of Portugal about the 18th. The lowest reading so far reported by a vessel is 28.45 inches, made during the forenoon of the 2d, near latitude 46° N., longitude 31° W., on the American steamship *Meanticut*. Table 1 indicates even lower pressure at Reykjavik, Iceland, on the 13th.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, February 1937*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.54	+0.01	30.30	21	28.80	13
Reykjavik, Iceland	29.38	−.16	30.27	27, 28	28.32	13
Lerwick, Shetland Islands	29.38	−.34	29.80	12, 25	28.70	5
Valencia, Ireland	29.57	−.33	30.12	20	28.97	25, 26
Lisbon, Portugal	30.19	+.09	30.42	17	29.86	8
Madeira	30.13	+.06	30.39	20	29.94	3
Horta, Azores	30.00	−.15	30.40	28	29.32	6
Belle Isle, Newfoundland	29.82	+.11	30.34	22	28.96	15
Halifax, Nova Scotia	29.87	−.04	30.32	21	29.00	15
Nantucket	29.91	−.13	30.36	20	29.16	14
Hatteras	30.03	−.08	30.54	12	29.31	16
Bermuda	30.01	−.11	30.42	13	29.26	6
Turks Island	30.03	−.05	30.11	4, 7	29.96	17
Key West	30.03	−.04	30.18	3	29.89	16
New Orleans	30.10	+.01	30.57	11	29.73	8

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—The northwestern area, north of 40° and west of midocean, appears to have been somewhat less stormy than during an average February. Other portions

of the North Atlantic experienced greater than usual storminess. During the final 9 days there was distinctly less turbulence than there had been previously.

As the month began a LOW of marked energy was central about 500 miles southeast of Newfoundland and pressure was mainly low to eastward as far as the British Isles. The principal center advanced northeastward and another storm of considerable strength developed on the 2d and 3d after moving from the North American Continent to near the earlier position of the first LOW. Another rapid development took place to southwestward of the second LOW and on the evening of the 4th was centered as a distinct cyclone off the coast near Wilmington, N. C., from where it traveled first toward the east-northeast; than for some distance it closely followed the thirty-sixth parallel eastward, attaining great strength by the evening of the 5th, but afterward losing force. Late on the 5th the American steamship *Boringuen*, near 36° N., 72° W., experienced winds of force 12, the earlier of two reports of such strength during the month.

The intense winds circulating around this LOW were felt notably from the Florida coast to the vicinity of Long Island, especially on the 4th, 5th, and 6th. Three barges from the tows of two tugs were sunk between the entrances of Chesapeake and Delaware Bays and a schooner was sunk not far from Savannah, Ga. Many large vessels suffered considerable injury from this storm, and on one of these, the Danish motorship *Chr. Sass*, bound northward off Cape Hatteras, a seaman was killed—apparently the only loss of life at sea that resulted from this storm.

Charts IX and X present the situations on the 5th and 6th, respectively.

On the 14th and 15th another important LOW was passing over New England and the Maritime Provinces and by the morning of the 16th was centered a short distance to northeastward of Belle Isle. Meantime a southwestern secondary LOW had developed, showing considerable strength near the Virginia Capes on the morning of the 16th. The northeastern center moved quickly toward western Iceland, which it reached on the forenoon of the 18th. As pressure over and to westward of southwestern Europe was quite high at this time, strong westerly winds prevailed over the eastern half of the chief steamship routes to the English Channel and to the north of Ireland. During the night of the 17th to 18th, the American steamship *Minnequa*, from Copenhagen for New York, when near 57° N., 23° W., encountered a force-12 wind.

Meantime the southwestern center traveled less rapidly toward the east-northeast, and by the 18th, when a moderate distance to southeastward of Newfoundland, had lost considerable strength. As a result of the high winds around this southwestern LOW, one abandoned barge was probably sunk, while many fishing schooners, particularly in the region from Cape Cod to Newfoundland, met exceedingly severe weather, two sailors from one schooner being drowned. The conditions on the 17th appear in Chart XI.

Fog.—There was less fog than during January just preceding over nearly all squares of the western third of the North Atlantic, also in most parts of the Gulf of Mexico where fog is likely to be encountered. In the 5°-square, 35° to 40° N., 75° to 80° W. fog was reported on 9 days, a greater number than in any other 5° area of the North Atlantic; here, as indeed nearly everywhere from waters near Florida to the vicinity of Newfoundland, there was less fog during the second half of February than during the first half.

To the eastward of the fortieth meridian there was generally more fog than during January just preceding. The period from 10th to 15th, inclusive, was especially notable for fog over the northeastern part of the North Atlantic Ocean.

Comparison with the average amount of fog during February shows that most North Atlantic areas had less fog than the average. However, from the Carolina coast to Cape Cod there was somewhat more than average, in spite of the decrease from the preceding month; and there was more than average likewise from the Bay of Biscay southwestward and southward nearly to the Azores and Madeira.

Two widely separated sections in low latitudes reported fog or conditions similar to fog. Close to the Tropic of Cancer near 35° longitude, fog was noted on the 3d and 4th, while near Vera Cruz it was met on the 24th.

Ice.—Ice densely packed interfered greatly with navigation near St. Johns, Newfoundland, and close to Sydney, Cape Breton Island. To the eastward of Newfoundland ice appeared near the chief steamship lanes earlier than usual, and on the 9th advices were issued for liners to shift to a more southerly route than that usually taken during February.

OCEAN GALES AND STORMS, FEBRUARY 1937

Vessel	Voyage		Position at time of lowest barometer		Gale began February	Time of lowest barometer February	Gale ended February	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Antinous, Am. S. S.	St. John, N. B.	Glasgow	47 35 N.	39 55 W.	1	Noon, 1	2	28.65	NNE.	NE, 9	N.	NE, 11	None.
Express, Am. S. S.	New York	Gibraltar	40 28 N.	39 06 W.	1	9p, 1	2	29.02	WNW.	NW, 11	WNW.	NW, 11	NW-WNW.
Laurent Meeus, Belg. M. S.	Houston	Amsterdam	41 21 N.	35 27 W.	1	9p, 1	2	28.64	WSW.	WSW, —	NW.	NW, 11	SW-NW.
Ipswich, Am. S. S.	Antwerp	Panama City	[1]40 24 N.	28 27 W.	1	4a, 2	2	28.94	S.	SW, 10	W	SW, 10	None.
Emilia, Am. S. S.	San Juan	New York	37 00 N.	72 24 W.	2	5a, 2	3	29.99	NW.	NW, 8	N	NW, 9	
Eastern Prince, Br. M. S.	Trinidad	do	27 42 N.	67 36 W.	2	8a, 2	3	29.88	NW.	W, 5	N	NW, 10	
Katendrecht, Du. M. S.	Houston	Flushing	44 33 N.	25 22 W.	[3]31	Noon, 2	2	[2]28.71	SSE.	SSW, 11	SW.	SSW, 11	SSW-SW.
New Brunswick, Br. S. S.	Freetown	Boston	29 39 N.	56 24 W.	2	10p, 2	5	29.56	SW.	SW, 9	NW.	W, 10	SW-W.
Rex, Ital. S. S.	Gibraltar	New York	38 04 N.	50 04 W.	2	Mdt, 2	4	29.07	WSW.	WSW, 9	N	N, 9	Steady.
Pipestone County, Am. S. S.	Havre	do	35 00 N.	61 40 W.	3	4p, 3	4	29.49	NW.	NW, 10	NNW.	NW, 10	None.
Gulfoil, Am. S. S.	Philadelphia	Port Arthur	31 37 N.	76 06 W.	4	Mdt, 4	5	29.78	W.	W, 7	NW.	WNW, 9	S-W-WNW.
Tulsa, Am. S. S.	Charleston	Liverpool	34 45 N.	74 45 W.	4	5a, 5	6	[2]29.56	SE.	NW, 8	NW.	NW, 11	SE-WSW-NW.
Monarch of Bermuda, Br. S. S.	Bermuda	New York	38 24 N.	71 24 W.	5	4p, 5	6	29.03	SE.	NE, 9	N.	NNE, 11	SE-NE-N.
Borinquen, Am. S. S.	New York	San Juan	[1]35 54 N.	71 46 W.	5	6p, 5	6	28.63	SE.	NW, 12	N.	NW, 12	NW-NNW.
Lara, Am. S. S.	do	do	33 10 N.	69 25 W.	5	Mdt, 5	6	29.26	WNW.	NW, 11	NW.	NW, 11	WNW-NW.
New Brunswick, Br. S. S.	Freetown	Boston	34 26 N.	62 19 W.	5	Noon, 6	7	29.04	SSE.	SW, 8	NW.	S, 11	S-SW-NW.
Ryoyo Maru, Jap. M. S.	London	Philadelphia	31 54 N.	59 53 W.	6	4p, 6	7	29.34	S.	WNW, 9	WNW.	WNW, 10	WSW-WNW.
Speybank, Br. M. S.	Sao Miguel	St. John, N. B.	40 51 N.	49 15 W.	8	9a, 7	9	29.36	ESE.	ESE, 6	NNW.	W, 11	S-E-N.
West Kyska, Am. S. S.	Ghent	New York	[1]49 53 N.	8 22 W.	7	10p, 7	8	29.09	NW.	NW, 8	W.	NNW, 9	SW-NNW.
Pres. Roosevelt, Am. S. S.	Southampton	do	50 15 N.	2 50 W.	8	4a, 8	9	29.04	NW.	S, 4	W.	NW, 11	S-W-NW.
Blankaholm, Swed. M. S.	Halifax	Gothenburg	43 03 N.	49 50 W.	8	9a, 9	9	28.89	WSW.	WNW, 10	NW.	WNW, 10	
Gand, Belg. S. S.	New Orleans	Havre	[1]35 38 N.	74 43 W.	11	11p, 10	11	[2]29.65	NNW.	NNW, 7	NNW.	NNW, 9	SW-NNW.
Falsterbo, Swed. M. S.	Rotterdam	Cristobal	[1]28 13 N.	37 21 W.	11	4a, 11	11	29.59	NW.	NW, 8	N.	N, 8	NW-N.
Pres. Roosevelt, Am. S. S.	Southampton	New York	45 58 N.	41 27 W.	12	6a, 12	13	29.24	WSW.	SW, 7	NW.	NW, 11	WSW-SW.
West Kyska, Am. S. S.	Ghent	do	[1]47 30 N.	38 30 W.	14	Noon, 14	15	29.19	NW.	NW, 8	NW.	N, 10	SW-N.
Flora, Du. S. S.	New York	Port au Prince	37 07 N.	74 00 W.	14	2p, 14	15	29.44	NW.	NW, 4	NW.	NW, 10	SW-NW.
American Importer, Am. S. S.	do	Liverpool	40 30 N.	61 43 W.	14	4a, 15	15	29.32	SSE.	S, 8	SSW.	SW, 10	S-W.
Bremen, Ger. S. S.	Cherbourg	New York	48 30 N.	23 30 W.	15	8a, 15	15	29.34	W.	WSW, 8	WNW.	W, 10	
American Trader, Am. S. S.	Southampton	do	42 05 N.	56 58 W.	15	Noon, 15	16	29.27	S.	SSW, 8	W.	S, 9	S-WSW.
West Kyska, Am. S. S.	Ghent	do	[1]44 32 N.	45 04 W.	15	Noon, 16	16	29.73	SW.	SW, 8	SW.	SW, 11	None.
Standard, Am. S. S.	New York	New Orleans	36 11 N.	75 00 W.	16	1p, 16	17	29.22	SW.	SW, 2	NW.	W, 10	SSW-W.
Steel Exporter, Am. S. S.	Gibraltar	Boston	39 34 N.	66 04 W.	16	Mdt, 16	18	29.14	NE.	NE, 7	NW.	N, 10	N-NE-NNE.
American Trader, Am. S. S.	Southampton	New York	[1]40 52 N.	66 19 W.	16	2a, 17	17	29.23	ENE.	NE, 8	N.	NNE, 10	ENE-NNE.
West Imboden, Am. S. S.	Para	Boston	33 00 N.	66 43 W.	16	4a, 17	18	29.44	SW.	SSW, 9	NNW.	NW, 9	SSW-W.
Executive, Am. S. S.	Gibraltar	New York	38 12 N.	62 21 W.	14	4p, 17	19	29.05	SE.	SW, 10	NE.	SW, 11	S-N.
Minnequa, Am. S. S.	Copenhagen	do	57 05 N.	23 04 W.	17	10p, 17	19	29.30	S.	WSW, 12	WNW.	WSW, 12	SSW-WSW.
Braheholm, Swed. S. S.	Newcastle	Portland, Maine.	43 42 N.	58 36 W.	17	Mdt, 17	18	[3]29.09	E.	NE	N.	N, 11	E-NE.
Bremen, Ger. S. S.	Cherbourg	New York	42 00 N.	58 24 W.	18	5a, 18	18	28.96	N.	NW, 6	N.	N, 11	
Atlantic Sun, Am. S. S.	Port Arthur	Marcus Hook	39 48 N.	75 25 W.	21	10p, 21	22	29.44	SE.	SE, 9	NW.	SE, 9	SE-NW.
Black Condor, Am. S. S.	Antwerp	Boston	49 00 N.	25 30 W.	25	4p, 25	26	29.26	W.	W, 8	WNW.	W, 10	
Ary Lensen, Br. M. S.	Gibraltar	Baltimore	36 38 N.	55 06 W.	25	4p, 25	27	[2]29.58	SW.	SW, 9	WNW.	NW, 9	SW-NW.
Tanimbar, Du. M. S.	St. Vincent	Halifax	39 22 N.	56 12 W.	26	4a, 27	28	29.37	SW.	W, 7	NW.	SW, 10	SW-NW.
Loosdrecht, Du. M. S.	Curacao	Liverpool	53 46 N.	4 18 W.	25	3a, 28	28	[2]28.82	SW.	NW, 10	N.	NNW, 11	NW-N.
Birmingham City, Am. S. S.	Cristobal	New York	31 10 N.	73 56 W.	28	2p, 28	28	29.62	SW.	W, 9	WNW.	W, 9	SSW-WNW.
NORTH PACIFIC OCEAN													
Hiye Maru, Jap. M. S.	Vancouver	Yokohama	47 37 N.	163 56 E.	1	2a, 2	2	29.20	SE.	WSW, 9	WNW.	SW, 10	SW-WSW.
Empress of Canada, Br. S. S.	Yokohama	Honolulu	34 51 N.	143 09 E.	2	4p, 2	3	29.25	ESE.	S, 11	W.	S, 11	SE-WSW.
Delftdyk, Du. M. S.	Vancouver	Balboa	44 35 N.	124 55 W.	3	6a, 4	4	29.12	SE.	SE, 8	WSW	SW, 8	ESE-SW.
Anna Maersk, Dan. M. S.	Los Angeles	Yokohama	33 41 N.	153 10 W.	4	Noon, 4	6	29.54	ENE.	E, 10	NE.	E, 10	NE-E-ENE.
Manoeran, Du. M. S.	Mambulao, P. I.	Los Angeles	34 20 N.	159 12 E.	5	2a, 5	5	29.87	N.	SSE, 2	N.	N, 9	SSE-W.
Athelking, Br. M. S.	San Francisco	Yokohama	34 46 N.	139 48 E.	7	8p, 7	8	30.04	NE.	NE, 8	NE.	NE, 9	
Manoeran, Du. M. S.	Mambulao, P. I	Los Angeles	36 45 N.	158 09 W.	8	4a, 11	11	30.28	NE.	NE, 8	NNE.	NE, 9	
Silverguava, Br. M. S.	Manila	Portland, Oreg.	36 00 N.	159 00 E.	10	10p, 9	10	29.98	NNW.	NNW, 6	N.	N, 10	S-W-NNW.
Makawao, Am. S. S.	San Francisco	Honolulu	35 42 N.	128 00 W.	9	1p, 10	10	29.80	SSE.	SSE, 7	SSE.	SSE, 8	
Indianan, Am. S. S.	do	Balboa	27 30 N.	115 36 W.	10	7a, 10	10	30.07	NE.	NE, 7	NE.	NE, 8	
Empress of Canada, Br. S. S.	Honolulu	Victoria, B. C.	30 19 N.	149 43 W.	10	Mdt, 10	11	29.64	N.	N, 8	NE.	NNE, 10	
Yeiyo Maru, Jap. S. S.	Estero Bay	Dairen	33 00 N.	142 38 E.	12	8p, 13	15	29.64	SE.	W, 5	NW.	W, 9	SE-W.
Nina Borthen, Nor. M. S.	Seishin	Los Angeles	46 12 N.	162 17 W.	12	4a, 13	15	29.43	SW.	SW, 8	W.	W, 9	SW-NW.
Do	do	do	43 31 N.	145 36 W.	15	3a, 16	17	29.81	SW.	WSW, 9	WNW.	WSW, 9	SW-WSW.
San Pedro Maru, Jap. M. S.	Yokohama	do	43 06 N.	166 20 E.	16	10p, 16	17	29.11	E.	SSW, 8	SW.	E, 9	E-SSW-SW.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	51 52 N.	142 28 W.	16	2p, 16	17	29.15	WNW.	WNW, 5	NW.	WNW, 11	SSW-WNW.
Toorak, Br. S. S.	Swatow	Los Angeles	43 30 N.	171 30 E.	16	3a, 17	17	28.86	E.	ESE, 9	SW.	ESE, 9	E-S-W.
Do	do	do	[1]45 03 N.	179 55 E.	18	4p, 18	18	28.62	WSW.	SW, 6	W.	W, 8	S-WSW.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	52 06 N.	162 17 W.	19	4a, 19	20	28.83	SSW.	SW, 10	W.	SW, 10	SSW-SW.
Empress of Russia, Br. S. S.	Yokohama	Vancouver, B. C.	45 45 N.	165 22 E.	21	8p, 21	22	28.85	W.	WSW, 8	SW.	SW, 10	NW-SW.
Mana, Am. S. S.	Portland, Oreg.	Nawiliwili	41 26 N.	134 50 W.	22	10p, 22	23	29.27	SSE.	SSE, 6	NNW.	NNW, 10	SSE-NNW.
Empress of Russia, Br. S. S.	Yokohama	Vancouver, B. C.	48 48 N.	178 40 E.	23	3a, 23	22	29.06	SE.	SE, 8	SW.	SSE, 9	SE-S.
Pres. McKinley, Am. S. S.	Victoria, B. C.	Yokohama	49 44 N.	173 04 E.	22	4a, 23	24	28.90	SSE.	N, 9	SW.	NW, 10	NE-NW.
Do	do	do	47 10 N.	161 55 E.	24	7p, 24	25	29.09	S.	SW, 7	NW.	SSW, 11	SSW-W.
Fernwood, Nor. M. S.	Manila	Los Angeles	36 20 N.	153 11 W.	24	Noon, 25	26	[2]29.68	WSW.	W, 8	NW.	W, 8	WSW-WNW.
Athelking, Br. M. S.	Nagasaki	San Francisco	36 14 N.	176 00 W.	27	11p, 27	[3]1	29.84	NW.	NW, 8	NNE.	N, 8	W-N.

[1] Position approximate. [2] Barometer uncorrected. [3] January.

NORTH PACIFIC OCEAN, FEBRUARY 1937

By WILLIS E. HURD

Atmospheric pressure.—The principal center of the Aleutian LOW as an average for February 1937, lay over and in the vicinity of the Gulf of Alaska, with 29.63 inches as the average barometer reading at Kodiak. A secondary low-pressure center lay between the western Aleutians and the Kuril Islands. At Kodiak the pressure was normal, but to the eastward—at Juneau—the average barometer, 29.70 inches, was a fifth of an inch below the normal of the month; while to the westward—at Dutch Harbor—the average of 29.86 was a quarter of an inch above the normal. Over the central Aleutians high pressure prevailed most of the time during the first 8 and the last 8 days of the month; deep cyclonic activity was confined to the intervening 12 days.

The North Pacific HIGH was poorly developed during February except over midocean where, at Midway Island, with an average pressure of 30.17, the departure from normal was +0.18. Considerable cyclonic activity prevailed between the Hawaiian Islands and the United States during the early half of February.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, February 1937 at selected stations*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Point Barrow	29.87	−0.25	30.76	1	29.32	16
Dutch Harbor	29.86	+.26	30.56	28	28.80	19
St. Paul	29.76	+.11	30.46	28	28.64	19
Kodiak	29.63	+.01	30.20	2,3	28.46	14
Juneau	29.70	−.22	30.33	3	28.83	14
Tatoosh Island	29.86	−.14	30.25	9	29.11	4
San Francisco	30.06	−.04	30.32	17	29.45	13
Mazatlan	29.93	.00	30.02	3	29.90	7, 8, 25, 26
Honolulu	30.00	−.05	30.17	16	29.76	7
Midway Island	30.17	+.18	30.34	14	29.94	20
Guam	29.91	.00	30.00	4	29.80	27
Manila	29.91	+.02	30.00	4, 5	29.74	27
Hong Kong	30.06	.00	30.30	16	29.83	28
Urakawa [1]						

[1] Data incomplete. Not used.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—The North Pacific Ocean was only moderately stormy during February, as was the case in the preceding 2 months. Although the extreme northeastern part of the ocean was the principal center of cyclonic activity, insofar as low pressure is concerned, yet transpacific shipping reported much less stormy weather over the eastern than along the western half of the northern steamer routes, where cyclones from middle and higher latitudes of the Far East traversed the northwestern quarter of the ocean toward the Aleutian Islands or the Arctic Ocean. This was the month's primary region of storminess. A secondary region of storminess was that lying between the Hawaiian Islands and the west coast of the United States. Elsewhere on the ocean, insofar as present reports indicate, gales were infrequent, although some occurred which were of considerable force.

In the primary storm area, the month opened with a cyclone over southern Japanese waters. This disturbance moved rapidly northeastward across the Kuril Islands and entered the Arctic Ocean on the 6th. It developed considerable energy east of Honshu; and on the 2d, when it was near 35° N., 143° E., the British steamship *Empress of Canada* encountered a gale from the south of force 11, with a barometer of 29.25. At some distance east of the Kurils on the same date, the Japanese motorship *Hiye Maru* met southwesterly gales of force 10. After the 2d, the storm had ceased to influence the weather appreciably along the main steamer routes.

Disturbed conditions prevailed between central Japan and longitude 170° E. from the 7th to 11th, and scattered gales of force 8–10 occurred over that region on several of the included dates. From the 13th to the 15th another progressive cyclone crossed the waters east of Japan accompanied by fresh gales. On the 16th and 17th the storm, then of considerable depth, was centered south of the western Aleutians, attended by fresh to strong gales. The cyclone center crossed the Aleutians into the Bering Sea late on the 18th. The pressure was low meanwhile over a large area, the British steamship *Toorak* reported a barometer of 28.62, with fresh gales, near 45° N., 180°.

From the 21st to 25th stormy conditions with low pressures prevailed between the western Aleutians and the southern Kurils. Gales of force 9–10 were reported between 45°–51° N., 165° E.–180° on the 21st–23d; but on the 24th–25th, midway between the western Aleutians and northern Japan, southwesterly changing to northwesterly winds of force 11 were encountered by the Yokohama-bound American steamship *President McKinley*.

In northeastern waters of the ocean the *President McKinley*, outward bound from Victoria, ran into a west-northwester of force 11 near 52° N., 145° W., on the 17th. At this time and during several preceding days the deepest cyclone of the month was central over the Gulf of Alaska. At Kodiak on the 14th pressure had fallen to 28.46, but was even lower (28.2) at Cordova. Although this cyclone spread far to the southward, ships traversing its lower reaches reported only a few gales and those were in scattered localities on the 14th, 16th, and 17th.

In the secondary area of storminess, mentioned earlier as lying to the westward of the United States and thence southwestward to near the Hawaiian Islands, nearly half the days of the month had disturbed weather, most of it occurring prior to the 15th. On February 4 a LOW that had remained off the Washington coast since the 1st, went inland with increased intensity, causing strong winds to gales in Washington and Oregon waters. At Tatoosh Island durings its passage the barometer fell to 29.11 inches. From early in the month until the 13th a LOW or a succession of LOWS occupied various parts of the ship routes northeast of the Hawaiian Islands, and during several days of this period local gales, mostly of force 8, but on the 4th and 11th of force 10, occurred in scattered localities. On the 10th the disturbed area expanded eastward toward the mainland, causing fresh gales a day's journey out from San Francisco. Three days later the last oceanic remnant of the LOW entered the California coast.

Gales of the Tropics.—No storms were reported from tropical waters of the Far East this month. In lower Mexican waters Tehuantepecer gales were reported of force 10 on the 11th and of force 7 on the 12th. The gale of the 12th blew from the north in the Gulf of Tehuantepec, but an observation on that day to the southward near 12° N., 100° W. gave a wind of force 7 from the east. An account of the Tehuantepecer of February 10–11, 1937, prepared by the observing officer of the British motorship *Skipsea*, is quoted below.

Fog.—Fog was reported on 4 days over the western part of the ocean; on 5 days, away from the coast, along the California-Hawaiian routes; and on 4 days between San Diego, Calif., and Point Eugenia, Lower California.

TEHUANTEPECER OF FEBRUARY 10–11, 1937

By WILLIS E. HURD

The following account of a Tehuantepecer, experienced during a voyage from San Pedro toward Panama, was prepared by Second Officer N. Clarke of the British Motorship *Skipsea*, Capt. L. Whitehead. The observer has so well described the characteristic preliminary signs of this winter phenomenon of the Gulf of Tehuantepec, as well as the gale itself and the effect of the wind upon the sea, that the account is quoted in its entirety. During the period of the Tehuantepecer the center of a strong high pressure area overlay the Gulf States, and a considerable pressure slope extended thence southward over the Gulf of Mexico, thus resulting in the spill of air across the isthmus and down the Pacific side of the pass entering upon the Gulf of Tehuantepec. Said Officer Clarke:

Position at noon, February 10, was latitude 15°22′ N., longitude 98°25′ W. Course S63E., 11½ knots. Wind southeast, force 2, slight sea and swell. Barometer 29.93 (uncorrected). The sunset on this day was brickred with red clouds reaching to the zenith. About 9 p. m. a short steep swell from the eastward was observed and at 10 p. m. wind backed to north-northeast, force 3. The swell increased rapidly, moving slowly round to north-northeast, and at 2 a. m., February 11, a large arched cloud stretching from north to south made its appearance, its lower arc being very black. It rose slowly toward the zenith and scattered there at 3 a. m., but was seen to have regained its arch-like formation on reaching the western horizon. There was no rain. At 3:30 a. m. wind increased to force 6; vessel by this time laboring heavily in high sea. At 4 a. m. vessel was hove to head to sea, for although wind was only force 6, the sea was very dangerous and vessel was receiving much damage. By 8 a. m. wind had risen to force 10 from north-northeast, with terrific squalls, sea very high, and a haze hung around the horizon. Barometer steady at 29.90. During the gale the sea was very remarkable. After a comparative smoothness of a few minutes, a procession of tremendous seas would strike the ship, generally three or four at a time. Some were observed to be so steep that their crests fell backward to windward. These seas could be seen quite easily for 2 or 3 miles in the heavy swell. Our noon position was 14° N., 95°50′ W., wind north-northeast 9, barometer 29.91. Vessel hove to and shipping heavy water. After noon cirrus clouds were observed moving to windward, and at 2 p. m. sea began to subside a little, with wind force 8. At 2:45 p. m. resumed course and full speed. By midnight wind had dropped to force 7, north-northeast, and barometer had risen to 29.97; high sea, heavy swell. At 8 a. m., February 12, wind had veered to southeast, force 5; moderate sea and cross swell, and the haze had left the horizon.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given, for the various sections of the climatological service of the Weather Bureau, the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, February 1937*

[For description of tables and charts, see REVIEW, January, p. 35]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	48.8	0.0	3 stations	83	8	Valley Head	14	11	4.93	−0.28	Dothan	9.52	Mobile Airport	2.32
Arizona	45.7	−2.5	2 stations	85	24	McNary	−7	27	1.59	+.34	Junipine	9.16	Gila Bend	T
Arkansas	44.2	+.7	El Dorado	84	8	2 stations	12	2	2.10	−1.16	Texarkana	3.69	Thornburg	.22
California	44.5	−3.7	2 stations	84	[1] 18	Bridgeport	−28	3	7.13	+2.72	Giant Forest	19.85	Brawley	.00
Colorado	27.0	−.2	Las Animas	77	5	2 stations	−33	[1] 9	1.22	+.23	Pagosa Springs (near).	9.32	2 stations	T
Florida	60.7	+.1	Avon Park	89	9	Bushnell	28	6	5.04	+1.86	St. Petersburg	10.93	Belle Glade	1.21
Georgia	48.6	+.1	3 stations	82	8	Clayton	11	26	5.29	+.37	Blakely	8.14	Augusta	3.71
Idaho	23.4	−4.5	Bungalow	66	27	Deadwood	−34	19	2.49	+.76	Roland	8.98	Salmon	.13
Illinois	29.7	+.5	Harrisburg	71	8	White Hall	−7	2	1.50	−.63	Anna	3.09	Golden	.46
Indiana	31.4	+1.0	Seymour	80	8	Frankfort	0	17	1.86	−.54	Princeton	3.10	Whiting	.64
Iowa	19.6	−2.6	Keokuk	60	8	3 stations	−24	10	1.04	−.05	Washington	3.06	Denison	T
Kansas	32.7	.0	3 stations	75	[1] 5	Healy	−11	1	.68	−.31	Blue Rapids	2.93	Atwood	.04
Kentucky	38.3	+1.4	2 stations	78	8	4 stations	11	[1] 2	2.40	−.97	Jenkins	4.70	Grant	1.13
Louisiana	53.8	+.1	do	84	8	3 stations	22	11	2.76	−1.79	Port Sulphur	6.70	Atchafalaya	.59
Maryland-Delaware	34.9	+1.0	do	72	[1] 8	Grantsville, Md	0	28	3.20	+.25	State Sanatorium, Md.	5.06	Princess Anne, Md.	1.99
Michigan	24.1	+3.7	do	63	8	Bessemer	−25	10	1.71	+.06	Painesdale	5.12	Onaway	.44
Minnesota	9.5	−2.9	do	47	[1] 18	Pokegama Falls	[illegible]	[illegible]	.95	+.21	Pigeon River Bridge	2.63	Tracy	.20
Mississippi	49.2	−.1	Yazoo City	84	8	2 stations	[illegible]	[illegible]	3.64	−1.23	Meridian	6.78	Biloxi	1.16
Missouri	32.4	−.5	Garber	74	7	Fulton	−1[illegible]	[illegible]	1.38	−.67	Seymour (near)	2.80	Dean	.38
Montana	17.0	−5.2	Grass Range	58	16	Outlook	−43	9	.72	+.03	Heron	4.95	2 stations	T
Nebraska	25.1	−1.0	2 stations	68	[1] 11	Ainsworth	−17	1	.23	−.47	Auburn	1.02	Ainsworth	.00
Nevada	31.2	−2.7	Las Vegas	80	24	2 stations	−20	1	1.71	+.65	Lewers Ranch	10.80	Las Vegas Airport	.06
New England	28.6	+6.1	Orono, Maine	61	21	Fort Kent, Maine	−19	5	2.57	−.56	Hiram, Maine	5.58	Eastport, Maine	.64
New Jersey	34.1	+3.4	Bellepiain	65	9	2 stations	4	[1] 4	2.29	−1.32	Little Falls	3.61	Camden	1.32
New Mexico	35.6	−1.7	Lovington	84	[1] 7	Selsor Ranch	−31	10	.92	+.21	Aspen Grove Ranch	5.08	5 stations	.00
New York	27.9	+5.6	Fredonia	64	9	Indian Lake	−21	4	2.35	−.32	North Lake	3.74	Ogdensburg	.86
North Carolina	42.5	−.1	2 stations	79	8	Mount Mitchell	−5	26	4.08	+.02	Swansboro	9.90	High Point	2.55
North Dakota	6.8	−2.9	Hettinger	55	15	Pembina	−35	1	.49	+.03	Cooperstown	3.31	Hettinger	.02
Ohio	31.6	+2.4	Chillicothe	75	8	2 stations	4	25	1.72	−.84	Lock No. 23	5.23	Lake Milton	.67
Oklahoma	41.7	+.8	Frederick	85	5	Boise City	5	1	.41	−.90	Fort Gibson	2.42	10 stations	T

[1] Other dates also.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, February 1937*—Continued

[For description of tables and charts, see REVIEW, January, p. 35]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Oregon	31.9	−3.2	Modoc Orchard	68	23	Danner	−18	1	4.09	+0.96	McNamers	23.45	Milton	0.35
Pennsylvania	31.4	+3.2	2 stations	77	8	Somerset	−12	28	2.32	−.53	Zionsville	4.92	Vandegrift	.76
South Carolina	46.7	−.7	3 stations	80	8	Caesars Head	10	26	4.26	−.01	Caesars Head	7.57	Winthrop College	2.84
South Dakota	16.4	−2.7	Rapid City	63	16	2 stations	−28	1	.37	−.19	Melette	1.59	Ottumwa	T
Tennessee	40.9	−.2	3 stations	80	8	Rugby	8	[1] 11	3.56	−.77	Morgan Springs	7.10	Halls	.93
Texas	51.0	−.3	do	97	[1] 8	2 stations	6	[1] 10	.53	−1.25	Bronson	4.05	12 stations	.00
Utah	26.2	−3.8	St. George	69	24	Woodruff	−30	1	1.72	+.45	Silver Lake	6.61	Hanksville	.02
Virginia	37.7	+.7	Cape Henry	77	9	2 stations	1	26	3.15	+.03	Clinchport	5.28	Hopewell	1.69
Washington	30.7	−3.6	South Bend (near)	67	24	do	−21	8	5.22	+1.21	Wynoochee Oxbow	21.68	Mottinger	.32
West Virginia	34.6	+1.5	London	80	9	McNeill	−3	17	3.33	+.22	Terra Alta	5.96	Upper Tract	1.20
Wisconsin	16.7	−.1	Superior	55	18	3 stations	−36	[1] 2	1.98	+.79	Oconto	4.16	Amery	.68
Wyoming	20.4	−1.8	Cody	64	11	West Yellowstone	−43	20	.96	+.17	Bechler River	10.06	Lagrange	T
Alaska (January)	17.9	+13.6	Dutch Harbor	55	14	Allakaket	−41	23	4.15	+1.68	Atka	9.83	Whale Island	.36
Hawaii	68.0	−.5	Olaa Mill	89	2	Kanalohuluhulu	38	11	13.86	+6.86	Station No. 39	49.43	Ka Lae	.78
Puerto Rico	71.3	−1.3	2 stations	92	[1] 26	Guineo Reservoir	38	2	1.24	−2.02	La Mina (El Yunque)	8.53	3 stations	.00

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau stations, February 1937*

[Compiled by Annie E. Small, by official authority U. S. Weather Bureau]

District and station	Elevation of instruments			Pressure			Temperature of the air									Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation			Wind				Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range				Total	Departure from normal	Days with 0.01 inch, or more	Average hourly velocity	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date					
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							30.8	+5.5										73	1.95	−1.3									6.0		
Eastport	76	67	85	29.81	29.90	−0.08	27.6	+6.1	49	20	34	10	8	21	26	26	22	80	0.64	−2.7	11	12.8	nw.	46	e.	22	5	8	15	6.8	6.9	T
Greenville, Maine	1,070	6	40																												
Portland, Maine	103	82	117	29.81	29.94	−.08	30.4	+6.6	55	13	37	12	2	24	24	26	19	65	3.17	−.8	7	8.9	n.	24	ne.	22	13	9	6	4.5	1.5	0.0
Concord	289	60		29.62	29.94	−.10	28.9	+6.1	57	13	38	7	3	20	35				3.28	+.4	6		nw.				6	11	11		1.8	
Burlington	403	11	48	29.50	29.96	−.07	25.6	+6.2	53	13	33	2	17	18	34	22	18	76	1.59	.0	9	10.4	nw.	44	se.	22	4	5	19	7.2	3.9	T
Northfield	876	12	60	28.98	29.97	−.07	22.4	+6.0	51	13	32	−2	17	12	44	19	16	80	2.46	+.2	12	7.5	n.	27	s.	22	5	7	16	7.1	8.3	3.0
Boston [1]	29	31	50	29.90	29.92	−.12	33.2	+4.4	56	13	40	10	2	27	26	29	22	67	1.31	−2.1	6	11.9	w.	35	ne.	16	9	8	11	5.8	T	.0
Nantucket	12	14	90	29.90	29.91	−.13	35.6	+4.9	52	9	41	16	3	30	30	33	29	78	1.30	−2.1	9	16.9	n.	51	ne.	17	2	7	19	7.5	3.1	.0
Block Island	26	11	46	29.90	29.93	−.13	34.6	+4.2	52	22	40	14	2	29	30	32	29	80	1.81	−1.8	8	19.2	w.	47	ne.	16	5	13	10	6.1	1.8	.0
Providence	160	215	251	29.76	29.94	−.11	34.2	+5.2	60	9	42	11	2	27	26	29	22	66	1.75	−1.9	7	13.1	nw.	38	se.	22	13	6	9	4.8	.5	.0
Hartford	159	70	104	29.79	29.97	−.09	33.0	+5.8	59	13	40	10	2	25	26				1.94	−1.9	7	9.5	nw.	32	nw.	2	13	6	9	5.0	.9	.0
New Haven	106	74	153	29.85	29.97	−.10	33.6	+4.6	52	13	41	10	3	26	22	29	20	61	2.22	−1.8	7	10.0	n.	35	se.	22	8	12	8	5.6	4.0	.0
Middle Atlantic States							35.4	+2.1										67	2.54	−0.7									6.4		
Albany	97	97	112	29.88	29.99	−.08	30.4	+6.3	55	13	38	8	3	23	27	26	18	63	2.08	−.4	7	8.1	nw.	34	se.	22	6	7	15	6.4	1.7	.0
Binghamton	871	57	79	29.03	29.99	−.09	28.4	+4.4	59	13	37	7	28	20	30				2.72	+.4	11	7.4	nw.	28	se.	21	4	6	18	7.6	9.7	.7
New York	314	415	454	29.63	29.98	−.10	34.9	+3.6	56	13	42	13	3	28	21	30	21	69	1.87	−2.0	8	15.5	nw.	56	nw.	2	6	11	11	6.1	3.6	.0
Harrisburg	374	94	104	29.60	30.01	−.08	33.0	+2.8	58	21	40	17	4	26	23	29	22	65	3.16	+.2	10	8.6	nw.	26	se.	21	6	11	11	6.1	4.5	.0
Philadelphia	114	174	367	29.88	30.02	−.08	35.8	+1.9	60	21	43	29	26	29	24	31	24	63	1.66	−1.7	10	13.7	nw.	45	se.	22	7	7	14	6.0	4.1	.0
Reading	323	283	306	29.65	30.02		34.2	+5.4	62	13	42	17	26	27	25	30	22	62	1.83	−1.6	11	13.1	nw.	43	se.	21	6	12	10	6.0	1.8	.0
Scranton	805	72	104	29.11	30.00	−.08	30.4	+3.1	59	13	39	12	4	22	29	26	20	65	2.47	−.6	8	7.2	nw.	26	nw.	2	3	12	13	6.7	4.6	T
Atlantic City	52	37	172	29.94	30.00	−.11	36.0	+2.4	57	9	42	18	26	30	20	32	27	71	3.05	−.3	12	17.1	w.	47	ne.	16	4	8	16	7.0	7.0	.0
Sandy Hook	22	10	57	29.95	29.98		34.6	+2.5	54	13	40	17	3	29	20	31	27	75	2.26	−1.5	7	16.4	w.	47	nw.	2	4	10	14	6.5	4.2	.0
Trenton	190	88	106	29.79	30.00		34.5	+3.8	58	21	42	16	4	27	24	31	25	69	1.52	−1.8	10	11.0	nw.	34	se.	22	7	11	10	6.0	2.9	.0
Baltimore	123	100	215	29.89	30.02	−.09	36.7	+1.3	60	13	44	20	11	29	26	32	24	62	3.52	+.1	11	11.8	nw.	38	s.	21	9	6	13	6.0	8.5	.0
Washington	112	62	85	29.90	30.03	−.08	36.6	+1.3	64	9	45	20	26	28	26	32	24	63	3.33	+.1	12	8.5	nw.	27	nw.	21	7	10	11	6.0	7.7	.0
Cape Henry	18	8	54	30.00	30.02		41.5	+.3	77	9	49	23	26	34	34	37	33	76	3.03	−.2	11	15.0	n.	45	nw.	5	9	4	15	6.3	6.5	6.5
Lynchburg	686	148	184	29.29	30.05	−.06	39.6	−.7	68	8	48	18	26	31	29	35	29	69	2.82	−.3	11	8.6	nw.	32	nw.	15	10	4	14	6.1	5.3	1.5
Norfolk	91	80	125	29.94	30.04	−.07	41.8	−.9	75	9	50	22	26	34	31	37	31	71	2.53	−.7	12	11.3	n.	30	se.	21	7	8	13	6.6	9.8	5.6
Richmond	144	11	52	29.89	30.05	−.06	39.3	−.3	73	8	48	20	3	30	33	34	29	72	2.42	−.8	11	8.4	sw.	32	nw.	21	8	6	14	6.2	3.5	1.4
Wytheville	2,304	49	55	27.58	30.04	−.08	34.2	−.9	72	8	43	12	25	26	32	30	25	73	2.29	−.7	15	8.6	w.	30	w.	21	7	8	13	6.4	8.5	4.0
South Atlantic States							47.5	−0.4										70	4.04	+0.3									5.8		
Asheville	2,253	89	104	27.65	30.08	−.05	38.0	−.5	70	8	47	14	26	28	37	32	26	69	2.73	−.4	15	10.9	n.	29	nw.	16	8	4	16	6.4	7.0	3.5
Charlotte	779	63	86	29.20	30.06	−.06	43.6	−.3	72	8	52	20	26	35	26	38	32	67	2.77	−1.4	10	8.3	sw.	30	sw.	21	7	6	15	6.2	5.1	2.3
Greensboro [1]	886	6	56	29.07	30.04		39.3		71	8	49	16	28	30	29	35	30	73	2.55		11	9.0	sw.	29	sw.	21	9	2	17	6.4	4.0	4.0
Hatteras	11	5	50		30.03	−.08	45.8	−1.6	64	9	52	27	26	40	22			78	5.33	+1.3	12	16.8	n.	45	n.	28	8	9	11		T	.0
Raleigh	376	103	146	29.63	30.04	−.07	43.1	−.1	75	8	51	21	26	35	29	39	35	79	3.40	−.5	13	9.7	sw.	28	nw.	16	9	7	12	5.7	7.8	5.0
Wilmington	72	73	107	29.98	30.05	−.07	47.8	−.1	72	8	56	25	26	40	27	42	35	68	5.18	+1.9	11	10.9	n.	33	nw.	16	11	7	10	5.1	T	.0
Charleston	48	11	92	30.02	30.07	−.05	51.0	−1.4	72	7	58	32	26	44	22	45	40	71	4.68	+1.7	10	11.5	n.	28	w.	16	11	4	13	5.8	.0	.0
Columbia, S. C	347	70	91	29.69	30.08	−.03	48.3	+.1	76	8	57	25	26	39	28	40	31	58	4.33	+.6	12	9.4	ne.	27	sw.	21	11	5	12	5.4	.0	.0
Greenville, S. C	1,039	139					43.2	−.1	68	9	52	21	26	34	29				3.90	−1.3	10		w.				11	2	15		2.5	.0
Augusta	182	62	77	29.86	30.06	−.06	49.6	−.3	78	8	59	27	26	40	32	43	36	64	3.71	−.4	10	7.2	nw.	24	nw.	21	8	8	12	6.0	.0	.0
Savannah	65	73	152	30.00	30.07	−.05	53.8	−.2	76	7	63	34	26	45	30	47	42	72	4.38	+1.2	11	11.8	nw.	37	nw.	16	9	7	12	5.7	.0	.0
Jacksonville	43	86	110	30.03	30.08	−.04	57.9	−.1	80	9	67	36	17	49	28	51	46	71	4.05	+1.1	9	8.9	nw.	27	w.	16	9	8	11	5.8	.0	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, February 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Florida Peninsula							**68.1**	**+1.6**										**77**	**6.09**	**+4.2**										**5.1**		
Key West	22	10	64	30.01	30.03	−0.04	72.6	+2.1	84	10	78	58	6	67	18	66	64	80	3.32	+2.0	11	10.8	se.	29	w.	28	13	10	5	4.6	0.0	0.0
Miami	25	124	168	30.02	30.05	−.05	69.4	+2.3	81	25	75	49	17	64	23	62	59	74	4.02	+2.2	10	11.4	se.	33	w.	16	8	11	9	5.5	.0	.0
Tampa	35	88	197	30.02	30.06	−.04	62.4	+.5	82	9	72	41	17	53	30	56	52	77	10.92	+8.4	8	12.3	s.	32	w.	21	12	8	8	5.2	.0	.0
Titusville	43	5	36	30.00	30.05	------	61.6	------	85	9	73	38	17	50	36	55	53	----	4.87	------	10	------	nw.	----	----	----	8	11	9	----	.0	.0
East Gulf States							**50.8**	**−0.8**										**70**	**4.81**	**0.0**									**6.0**		
Atlanta [1]	976	5	53	29.02	30.07	−.05	44.4	−.9	73	8	54	20	26	35	33	38	33	69	4.52	−.3	10	11.3	nw.	32	nw.	16	8	6	14	6.0	.0	.0
Macon	370	79	87	29.68	30.08	−.04	49.0	−.3	76	7	59	25	26	39	36	42	35	65	5.08	+.6	10	8.2	nw.	30	nw.	16	10	7	11	5.6	.0	.0
Thomasville	273	49	58	29.77	30.09	−.03	54.6	−.4	75	24	64	30	11	45	32	48	44	78	7.22	+2.8	11	------	nw.	----	----	----	9	6	13	----	.0	.0
Apalachicola	35	11	----	30.03	30.07	------	57.0	+.7	74	24	65	36	11	49	26	51	47	75	5.42	+1.5	9	10.6	n.	26	n.	10	6	8	14	6.4	.0	.0
Pensacola	56	149	185	30.03	30.09	−.02	54.4	−.8	72	8	62	32	11	47	25	51	49	84	3.79	−.6	11	13.9	n.	52	s.	21	7	10	11	5.8	.0	.0
Anniston	741	9	----	----	----	----	46.8	+1.0	78	8	56	22	11	37	33	----	----	----	5.14	−.1	12	------	nw.	----	----	----	10	7	11	----	.0	.0
Birmingham	700	11	48	29.31	30.10	−.02	46.4	−1.6	80	8	56	23	11	37	38	40	33	64	4.03	−1.0	10	9.0	nw.	28	s.	8	9	7	12	5.6	.0	.0
Mobile	57	86	105	30.03	30.09	−.02	53.0	−1.7	74	20	62	31	11	44	28	47	41	69	3.29	−2.0	7	11.6	n.	35	n.	10	6	6	16	6.6	.0	.0
Montgomery	218	92	105	29.85	30.11	−.01	50.1	−1.5	79	8	59	29	11	41	31	43	37	67	5.51	+.1	9	8.7	n.	28	nw.	16	10	5	13	5.6	.0	.0
Meridian	375	67	92	29.69	30.10	−.01	48.4	−1.2	79	8	58	25	11	39	33	42	35	64	6.78	+1.3	10	7.7	n.	24	nw.	15	10	5	13	5.7	.0	.0
Vicksburg	247	65	73	29.84	30.11	+.01	49.4	−2.4	80	8	57	30	11	42	28	43	36	64	4.74	−.1	9	9.1	n.	35	nw.	20	9	5	14	6.1	.0	.0
New Orleans	53	76	84	30.04	30.10	+.01	56.2	−1.1	78	8	64	37	11	49	27	49	44	68	2.15	−2.1	7	8.6	ne.	21	ne.	10	4	9	15	7.0	.0	.0
West Gulf States							**52.0**	**+0.4**										**66**	**0.99**	**−1.5**									**5.8**		
Shreveport	249	92	227	29.82	30.10	+.01	51.1	+.2	81	7	60	32	26	42	33	44	36	60	2.28	−1.0	6	13.5	s.	37	nw.	20	9	9	10	5.3	T	.0
Bentonville	1,303	12	38	28.68	30.08	−.02	38.4	−.1	71	7	49	15	1	28	43	----	----	----	1.10	−1.0	5	8.9	n.	25	s.	12	7	7	14	----	.8	T
Fort Smith	457	79	94	29.57	30.07	−.03	43.3	+.5	77	7	53	23	1	33	41	37	28	59	.89	−1.7	4	10.2	e.	31	w.	20	9	9	10	5.5	.3	.0
Little Rock	357	94	102	29.71	30.10	−.01	44.2	−.7	78	7	53	23	2	36	36	38	30	61	2.00	−1.8	7	9.9	s.	31	nw.	15	8	8	12	6.1	T	.0
Austin	605	136	148	29.43	30.06	------	53.8	+.4	82	7	64	29	28	43	35	46	38	60	.12	−2.2	3	9.1	s.	32	nw.	20	10	8	10	5.1	.0	.0
Brownsville	57	88	96	29.95	30.01	------	62.6	.0	91	20	71	40	2	55	27	58	55	81	1.30	+.1	9	11.4	se.	32	n.	9	5	13	10	6.7	.0	.0
Corpus Christi	20	11	78	30.03	30.05	.00	60.0	+1.6	87	20	67	36	28	52	33	54	50	77	.58	−.9	4	11.3	n.	31	n.	15	3	11	14	7.2	.0	.0
Dallas	512	220	227	29.51	30.06	------	49.0	------	80	23	59	25	28	39	32	42	33	59	.28	−2.0	3	14.0	s.	47	w.	20	13	3	12	4.6	T	.0
Fort Worth	679	92	110	29.34	30.07	.00	48.8	+.5	82	7	60	25	28	38	36	----	----	----	.30	−1.5	6	12.1	n.	38	n.	20	16	6	6	3.5	.1	.0
Galveston	54	106	114	30.02	30.08	+.01	57.8	+1.5	76	24	63	38	28	53	18	54	50	78	1.22	−1.6	8	12.5	s.	33	nw.	20	7	5	16	6.9	.0	.0
Houston	138	292	314	29.93	30.08	------	56.3	+.4	80	8	64	34	28	48	25	----	----	----	.45	−2.7	8	13.4	s.	35	nw.	20	7	7	14	6.3	.0	.0
Palestine	510	64	72	29.55	30.09	+.01	50.9	−.3	78	7	61	30	2	41	36	45	37	63	1.59	−1.5	7	9.8	s.	30	nw.	20	9	6	13	6.0	T	.0
Port Arthur	34	58	66	30.04	30.08	------	56.0	------	78	15	62	37	28	50	22	----	----	----	1.59	−2.0	10	12.3	s.	37	nw.	21	6	7	15	6.8	.0	.0
San Antonio	693	242	301	29.32	30.05	.00	56.2	+.8	84	15	67	29	28	46	30	48	40	61	.13	−1.5	6	11.7	ne.	41	se.	17	8	9	11	5.8	.0	.0
Ohio Valley and Tennessee							**35.7**	**−0.4**										**70**	**2.20**	**−1.2**									**6.8**		
Chattanooga	762	71	214	29.27	30.01	−.12	43.5	−.6	76	8	52	22	26	35	29	37	29	60	3.33	−1.6	14	9.5	ne.	42	w.	21	7	7	14	6.1	3.2	1.5
Knoxville	995	66	84	29.00	30.09	−.03	40.4	−1.5	75	8	50	19	26	31	33	35	29	69	4.51	.0	16	7.5	w.	29	w.	21	8	5	15	6.3	6.6	1.9
Memphis	399	78	86	29.66	30.09	−.02	42.8	−1.5	75	8	49	24	2	36	34	37	30	64	1.95	−2.4	8	10.2	n.	37	nw.	8	7	9	12	5.9	T	.0
Nashville	546	168	188	29.51	30.11	−.01	40.2	−1.4	77	8	48	20	26	32	28	36	30	70	1.90	−2.2	11	11.4	nw.	39	se.	20	3	12	13	6.8	1.2	.4
Lexington	989	6	----	----	----	----	35.5	+.1	74	8	44	15	11	27	33	----	----	----	2.77	−.8	14	------	sw.	----	----	----	12	8	8	----	6.7	2.5
Louisville	525	188	234	29.52	30.08	−.03	35.8	−1.4	73	8	44	13	25	28	34	33	28	72	1.65	−1.9	12	12.9	s.	41	sw.	21	7	10	11	6.1	6.8	T
Evansville	431	76	116	29.59	30.08	−.03	35.8	−.5	65	8	43	15	10	28	33	32	26	69	1.88	−1.4	14	12.2	nw.	43	sw.	8	5	7	16	6.8	3.9	1.0
Indianapolis	822	194	230	29.12	30.04	−.06	30.4	−.7	68	8	38	8	10	23	39	28	23	71	1.68	−1.0	10	13.4	w.	37	w.	21	3	13	12	7.1	2.3	.0
Terre Haute	575	63	149	29.40	30.03	------	32.4	------	67	8	41	9	10	24	40	29	24	72	1.94	−.7	11	12.3	nw.	38	sw.	21	5	10	13	6.5	3.5	T
Cincinnati	627	11	51	29.36	30.06	−.04	33.4	+.6	73	8	41	12	25	26	33	29	24	71	1.33	−1.7	11	9.7	sw.	35	sw.	21	3	8	17	7.6	4.7	.0
Columbus	822	90	210	29.14	30.04	−.05	32.3	+1.6	72	8	40	10	25	24	36	29	24	72	.87	−1.8	12	12.3	s.	43	sw.	21	4	8	16	7.3	1.3	.0
Dayton	900	58	153	29.04	30.03	------	32.2	+.8	71	8	39	10	25	25	32	----	----	----	1.71	−1.0	10	11.5	sw.	41	w.	21	4	10	14	6.6	.9	.0
Elkins	1,947	59	78	27.95	30.09	−.01	31.6	.0	74	8	41	8	6	22	38	28	24	77	3.48	+.4	17	7.5	w.	34	w.	14	5	5	18	7.7	9.6	.5
Parkersburg	637	77	84	29.41	30.08	−.02	34.8	+.6	76	8	43	14	25	27	34	31	26	74	2.58	−.6	15	8.2	sw.	30	sw.	21	2	10	16	7.2	3.6	.0
Pittsburgh [1]	1,273	39	54	28.61	30.00	−.09	30.6	−1.7	72	8	39	12	25	22	32	27	22	75	1.40	−1.2	14	13.0	sw.	44	nw.	14	4	7	17	7.4	6.0	T
Lower Lake Region							**28.8**	**+3.6**										**76**	**2.05**	**−0.4**									**7.4**		
Buffalo	768	243	280	29.11	29.97	−.09	28.6	+4.3	62	8	35	9	4	22	37	26	22	76	2.12	−.8	17	18.0	w.	47	sw.	22	4	7	17	7.4	10.9	3.1
Canton	448	10	61	29.46	29.96	------	23.4	+5.4	55	21	32	−4	17	14	33	21	19	86	1.45	−.8	9	9.3	w	28	se.	21	3	7	18	7.2	10.0	3.3
Ithaca	836	77	100	29.05	29.98	------	28.2	+3.7	57	21	36	3	28	20	28	25	19	71	2.22	+.2	13	10.9	nw.	40	se.	21	6	4	18	7.2	10.1	3.5
Oswego	335	71	85	29.59	29.97	−.09	28.8	+4.9	51	13	35	6	4	23	23	26	21	73	3.37	+.7	13	11.5	se.	28	w.	15	3	4	21	7.8	13.1	3.3
Rochester	523	86	102	29.39	29.98	−.08	29.2	+4.6	58	21	36	12	3	22	29	26	20	69	1.38	−1.3	14	9.9	w.	30	w.	15	4	9	15	7.2	6.1	2.0
Syracuse	596	65	79	29.32	29.98	−.09	29.8	+5.7	58	21	37	5	3	22	25	----	----	----	3.14	+.4	15	8.3	w.	24	nw.	2	4	4	20	7.4	12.4	.0
Erie	714	130	166	29.19	29.98	−.09	30.5	+3.6	67	8	37	13	28	24	35	27	23	75	2.15	−.4	11	15.5	w.	45	se.	21	3	7	18	7.8	6.5	1.2
Cleveland	762	267	318	29.15	30.00	−.07	30.9	+3.5	69	8	38	12	25	24	33	28	23	75	1.74	−.8	13	17.8	w.	53	w.	8	1	7	20	8.4	6.5	.0
Sandusky	629	5	67	29.30	30.00	−.07	30.6	+3.2	68	8	38	12	25	23	37	----	----	----	2.41	+.3	10	11.7	sw.	35	sw.	22	3	12	13	6.9	2.1	.0
Toledo	628	79	87	29.30	30.01	−.06	28.8	+1.5	65	8	36	11	25	22	34	26	22	75	1.59	−.5	10	11.7	w.	32	w.	22	4	10	14	6.8	2.0	.0
Fort Wayne	857	69	84	29.06	30.01	------	28.1	+.5	64	8	35	7	25	21	36	26	23	81	1.41	−.9	10	12.0	w.	35	sw.	21	4	9	15	7.0	2.8	.0
Detroit [1]	626	5	78	29.28	29.98	−.08	28.2	+2.9	58	8	35	9	10	21	29	25	20	74	1.64	−.5	10	12.4	sw.	35	sw.	22	3	10	15	7.1	1.8	.0
Upper Lake Region							**22.2**	**+3.1**										**81**	**1.92**	**+0.1**									**6.8**		
Alpena	609	13	89	29.24	29.93	−.10	24.2	+6.2	47	12	31	6	11	18	26	22	18	78	1.02	−.7	9	12.7	nw.	37	se.	8	5	8	15	6.9	5.2	T
Escanaba	612	41	49	29.24	29.93	−.13	20.0	+4.6	41	12	28	−6	10	12	28	18	15	85	3.88	+2.4	14	9.0	s.	24	w.	6	8	7	13	6.3	17.8	8.7
Grand Rapids	707	70	244	29.16	29.96	−.09	27.2	+3.5	56	8	34	8	10	21	31	25	21	78	1.62	−.6	11	13.1	sw.	37	sw.	21	5	3	20	7.5	12.0	1.4
Lansing	878	5	90	28.99	29.96	------	25.9	+3.0	53	8	33	7	10	19	28	24	22	87	1.02	−.9	10	11.2	sw.	28	w.	6	3	11	14	7.3	5.0	T
Ludington	637	5	54	29.21	29.93	------	25.9	+3.4	47	21	32	6	3	20	25	23	----	----	1.57	−.4	17	------	w.	----	----	----	6	2	20	----	10.1	1.5
Marquette	734	77	111	29.06	29.89	−.16	20.8	+4.5	47	12	28	−2	10	14	31	19	17	87	3.04	+1.1	15	10.5	w.	29	sw.	10	4	8	16	7.1	26.7	17.5
Sault Sainte Marie	614	11	52	29.21	29.94	−.09	18.0	+5.4	40	12	27	−12	25	9	37	17	14	83	2.54	+.6	19	8.8	s.e	30	nw.	6	4	9	15	7.3	21.8	19.9
Chicago	673	7	131	29.24	30.00	−.08	26.4	+.1	56	8	34	1	10	19	38	24	19	73	.63	−1.5	12	12.5	w.	30	w.	21	8	6	14	6.4	3.1	.0
Green Bay	617	109	141	29.23	29.92	−.14	19.6	+2.2	43	13	28	−11	10	11	31	18	14	78	2.33	+.8	10	11.8	sw.	29	w.	21	9	3	16	6.4	6.1	.4
Milwaukee	681	97	221	29.19	29.95	−.11	24.0	+1.2	49	13	32	−2	10	16	31	22	18	77	1.72	−.1	8	14.6	w.	35	se.	7	9	4	15	6.1	1.9	T
Duluth	1,133	5	47	28.64	29.92	−.16	12.0	+.6	40	18	21	−23	10	3	30	11	7	81	1.79	+.7	12	15.2	nw.	53	nw.	21	8	6	14	6.3	17.0	11.4

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, February 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*							*0–10*	*In.*	*In*
North Dakota							6.5	−1.4										86	0.46	0.0									5.2		
Moorhead, Minn.	940	50	58	28.94	30.02	−0.09	5.6	−2.5	36	18	15	−27	9	−4	34	6	5	92	.77	+.1	8	10.0	nw.	26	nw.	13	1	14	13	7.2	15.7	13.0
Bismarck	1,674	8	57	28.15	30.04	−.08	8.6	−1.7	40	16	19	−27	1	−2	40	8	4	77	.39	.0	4	9.3	nw.	36	nw.	13	13	10	5	4.4	5.8	3.4
Devils Lake	1,478	11	44	28.34	30.01	−.10	4.6	−.5	35	16	14	−25	1	−4	36	4	3	94	.46	.0	7	10.3	nw.	33	nw.	13	8	12	8	5.5	5.1	6.6
Grand Forks	833	12	67	------	------	------	3.1	------	35	18	14	−29	1	−8	36	3	------	----	.74	------	8	------	nw.	35	nw.	13	7	12	9	----	8.6	16.2
Williston	1,878	42	50	27.95	30.04	−.07	7.2	−.9	40	12	17	−26	9	−3	35	7	3	79	.20	−.2	7	8.3	nw.	32	nw.	12	12	12	4	3.8	2.5	5.9
Upper Mississippi Valley							24.1	−0.9										77	1.54	−0.2									5.8		
Minneapolis	919	105	208	28.94	29.97	------	13.4	−2.5	45	18	22	−15	10	5	30	12	9	81	.48	−.5	6	12.8	w.	33	w.	13	7	8	13	6.4	7.6	3.0
La Crosse	714	11	48	29.18	29.99	−.09	16.7	−2.5	45	18	27	−20	10	7	37	15	11	78	1.69	+.6	9	6.2	w.	17	n.	21	9	7	12	5.6	12.2	4.9
Madison	974	70	78	28.87	29.97	−.10	19.6	+.5	43	13	28	−9	10	12	34	17	14	83	1.63	+.1	13	10.1	w.	27	nw.	21	9	5	14	5.9	4.4	3.3
Charles City	1,015	10	51	28.88	30.01	−.09	14.7	−2.4	40	18	25	−19	10	5	40	13	11	86	1.25	+.2	7	8.6	nw.	25	n.	21	9	8	11	5.8	9.7	5.4
Davenport	606	66	161	29.34	30.03	−.07	25.0	+.1	50	20	33	−1	10	17	38	22	17	74	1.61	.0	9	12.6	nw.	38	nw.	21	8	8	12	5.9	3.9	.1
Des Moines	861	5	99	29.10	30.05	−.06	21.4	−2.3	47	18	29	−5	1	13	34	20	16	80	.80	−.3	8	11.7	nw.	38	nw.	13	10	6	12	5.2	8.2	2.6
Dubuque	699	60	79	29.22	30.01	−.08	21.0	−1.2	44	18	29	−6	10	13	31	18	14	75	2.29	+.9	12	7.9	nw.	24	nw.	21	12	4	12	5.4	8.3	5.0
Keokuk	614	64	78	29.36	30.05	−.06	27.8	−.5	60	8	37	1	10	19	47	23	17	66	1.51	.0	7	9.8	nw.	34	nw.	21	12	3	13	5.5	3.6	.1
Cairo	358	87	93	29.68	30.08	−.04	37.4	−1.1	67	8	45	18	10	30	34	35	33	83	1.57	−1.6	8	11.4	s.	32	sw.	21	6	10	12	6.7	3.6	1.6
Peoria	609	11	45	29.35	30.04	−.06	27.8	+1.9	54	8	36	1	10	19	39	25	21	79	2.46	+.4	7	9.8	w.	29	w.	21	11	8	9	5.1	2.0	.0
Springfield, Ill.	636	5	191	29.33	30.03	−.07	30.4	+.9	56	8	39	5	10	22	36	27	22	73	1.67	−.7	12	13.9	nw.	38	w.	21	7	6	15	6.5	4.5	T
St. Louis	568	179	303	29.43	30.06	−.05	33.6	−1.2	65	8	42	9	10	25	43	29	22	66	1.52	−1.0	9	14.8	nw.	39	nw.	21	9	7	12	5.9	1.4	.3
Missouri Valley							25.6	−0.7										73	0.55	−0.8									5.4		
Columbia, Mo.	784	6	64	29.19	30.06	−.05	31.2	−.5	61	8	40	−9	2	22	43	----	----	----	.66	−1.4	6	10.0	nw.	34	nw.	21	9	9	10	5.3	6.5	.7
Kansas City[1]	750	32	45	29.23	30.07	−.04	31.2	.0	61	7	40	9	10	23	38	27	21	69	.86	−.9	6	12.2	sw.	39	nw.	15	8	7	13	6.0	3.9	T
St. Joseph	967	11	49	28.99	30.06	------	27.6	------	54	18	36	4	1	20	31	24	19	73	.89	−.8	6	10.2	nw.	32	nw.	13	13	4	11	5.2	5.7	.4
Springfield, Mo.	1,324	98	104	28.62	30.06	−.05	34.8	−.4	70	7	44	9	2	26	50	31	25	70	1.15	−1.2	6	12.1	se.	34	nw.	15	8	11	9	5.5	2.4	T
Topeka	987	65	87	28.97	30.06	------	30.4	−.6	60	18	39	4	1	22	33	27	21	70	.61	−.9	5	10.6	nw.	32	nw.	15	11	5	12	5.5	5.3	T
Lincoln	1,189	11	81	28.74	30.06	−.04	25.0	−1.1	49	18	33	−3	1	17	34	22	17	70	.21	−.7	7	11.8	nw.	37	nw.	15	10	8	10	5.3	1.9	T
Omaha[1]	982	31	44	28.96	30.06	−.05	22.2	−3.3	46	18	31	−7	1	14	40	20	16	76	.22	−.7	5	13.0	nw.	42	nw.	13	10	6	12	5.5	2.1	T
Valentine	2,598	47	54	27.23	30.06	−.03	22.5	+1.1	60	16	35	−10	1	10	40	18	13	69	.04	−.5	4	10.2	nw.	35	nw.	15	9	10	9	5.4	.4	.0
Sioux City	1,138	64	106	28.78	30.05	−.07	19.3	−1.7	49	18	28	−11	1	10	41	18	14	79	.30	−.5	5	12.3	nw.	38	nw.	13	11	5	12	5.5	3.2	.7
Huron	1,307	59	74	28.58	30.06	−.06	14.2	−.1	41	18	24	−17	1	5	38	12	10	84	.55	.0	5	10.8	nw.	38	w.	13	13	9	6	4.6	7.7	T
Northern Slope							21.6	−0.9										69	0.60	−0.1									6.1		
Havre	2,507	11	67	27.28	30.04	−.03	12.0	−1.6	44	16	22	−29	9	2	55	11	7	77	.24	−.3	5	10.3	sw.	40	w	17	9	12	7	4.8	3.0	4.0
Helena	4,124	85	111	25.67	30.00	−.11	22.8	−.2	46	11	32	−10	8	14	45	19	12	63	.18	−.5	10	8.8	sw.	34	sw.	5	1	8	19	8.1	4.2	.5
Missoula	3,263	80	91	------	------	------	26.5	−.2	45	11	34	1	1	19	36	----	----	----	1.03	+.2	15	7.7	w.	36	ne.	25	1	7	20	7.6	18.0	2.3
Kalispell	2,973	48	56	26.82	29.97	−.11	21.8	−1.5	42	12	31	−9	9	13	27	21	18	81	1.03	−.1	14	5.4	w.	28	sw.	16	2	10	16	7.6	14.5	15.0
Miles City	2,371	48	55	27.42	30.08	−.01	14.4	−2.4	41	12	25	−21	9	4	43	13	7	69	.23	−.3	6	6.3	s.	34	nw.	12	5	14	9	5.8	3.2	1.0
Rapid City	3,259	50	58	26.51	30.06	−.02	23.6	+.2	63	16	36	−17	9	11	46	20	14	70	.24	−.2	3	8.8	n.	41	ne.	18	12	11	5	4.3	2.6	.0
Cheyenne[1]	6,144	5	39	23.79	29.97	−.06	26.5	−.8	56	16	39	−5	27	14	42	21	11	54	.27	−.4	4	18.0	nw.	56	nw.	5	11	7	10	5.5	2.7	.4
Lander	5,372	60	68	24.50	30.00	−.08	23.6	+1.1	53	14	37	−13	1	10	42	20	12	62	.33	−.3	4	5.8	sw.	51	sw.	18	13	11	4	4.2	3.0	T
Sheridan	3,790	10	47	25.98	30.04	------	18.5	------	56	12	33	−23	8	4	52	16	10	71	1.45	+.8	12	5.3	nw.	33	nw.	12	5	11	12	6.2	18.0	6.6
Yellowstone Park	6,241	12	46	23.73	30.08	−.02	17.8	−3.2	40	24	27	−13	20	9	29	16	10	70	1.30	+.7	13	10.5	sw.	32	sw.	17	1	8	19	7.9	18.6	8.7
North Platte	2,821	11	51	27.01	30.05	−.02	26.5	−.1	64	18	38	−7	1	15	41	22	17	74	.30	−.2	5	7.7	w.	29	nw.	15	11	8	9	5.3	4.8	T
Middle Slope							34.0	+0.3										61	0.48	−0.4									5.3		
Denver	5,292	106	113	24.60	29.95	−.06	33.4	+.7	66	5	45	4	1	22	39	26	13	47	.58	.0	5	9.4	s.	36	nw.	17	10	12	6	5.0	11.7	0.0
Pueblo	4,685	80	86	25.18	29.94	−.06	34.8	+1.9	68	5	49	−2	26	20	49	28	16	50	.60	+.1	5	9.0	nw.	36	nw.	7	9	16	3	4.6	6.8	.0
Concordia	1,392	50	58	28.54	30.06	−.03	28.4	−1.4	52	18	36	4	1	21	28	26	21	76	.32	−.6	3	9.3	n.	39	nw.	15	9	11	8	5.5	3.7	.3
Dodge City	2,509	10	86	27.38	30.05	−.01	33.6	+.4	68	7	45	2	1	22	43	28	20	64	.56	−.2	3	12.1	sw.	35	n.	15	8	12	8	5.5	6.4	T
Wichita	1,358	85	93	28.59	30.07	−.01	33.7	−.7	63	7	42	7	1	25	34	29	23	67	.73	−.5	3	12.2	sw.	32	sw.	18	9	9	10	5.5	4.7	.8
Oklahoma City	1,214	10	47	28.74	30.05	−.02	40.4	+.8	76	7	51	12	1	30	40	34	25	61	.12	−1.0	4	11.6	s.	33	nw.	15	9	8	11	5.6	.6	T
Southern Slope							47.5	+1.6										48	0.15	−0.6									5.2		
Abilene	1,738	10	52	28.22	30.06	+.01	48.0	+.8	84	7	60	19	28	36	35	38	26	49	.03	−1.0	2	11.0	s.	34	w.	20	13	3	12	5.3	T	.0
Amarillo	3,676	10	49	26.22	30.01	−.01	40.4	+2.3	75	5	53	11	1	28	40	31	18	47	.18	−.5	3	11.1	sw.	30	sw.	7	8	8	12	6.0	1.1	.0
Del Rio	960	63	71	29.02	30.01	+.01	57.2	+1.2	93	7	70	32	28	45	45	47	36	53	.18	−.4	3	8.8	se.	31	nw.	20	11	5	12	5.5	.0	.0
Roswell	3,566	75	85	26.36	30.00	+.02	44.4	+1.9	79	5	59	14	11	29	54	35	20	45	.21	−.4	4	9.0	s.	37	nw.	20	14	7	7	4.2	.8	.0
Southern Plateau							42.6	−1.6										51	0.72	+0.2									3.8		
El Paso	3,778	82	101	26.20	30.02	+.07	49.3	+.3	75	24	62	23	11	37	35	39	26	45	.32	−.1	5	8.6	w.	30	sw.	7	15	8	5	3.7	.6	.0
Albuquerque[1]	4,972	5	39	25.04	30.02	------	37.3	−3.2	67	24	52	10	9	22	42	30	19	52	.11	−.2	2	9.5	n.	42	sw.	7	14	7	7	4.4	T	.0
Santa Fe	7,013	38	53	23.17	30.02	+.04	32.6	−.5	56	24	43	10	10	23	31	27	18	54	.84	+.1	6	7.1	n.	34	sw.	7	15	5	8	4.5	4.8	.0
Flagstaff	6,907	10	59	23.29	29.99	−.01	27.6	−3.2	59	23	42	−5	1	14	45	25	----	73	2.79	------	7	8.3	nw.	40	sw.	7	6	12	10	----	8.0	T
Phoenix	1,107	39	51	28.84	30.01	+.02	54.7	−.4	78	24	68	30	9	41	39	45	32	48	.76	.0	5	5.5	e.	21	sw.	7	16	5	7	3.6	.0	.0
Yuma	141	9	54	29.89	30.04	+.04	57.8	−.8	80	23	71	32	2	45	37	46	30	36	.08	−.3	3	6.6	n.	26	w.	7	19	4	5	2.8	.0	.0
Independence	3,957	5	26	25.96	30.05	−.01	38.6	−3.6	65	20	52	3	1	25	36	32	22	----	2.24	+1.5	4	------	nw.	----	------	----	20	4	4	----	T	.0
Middle Plateau							30.4	−3.1										72	0.97	0.0									5.6		
Reno	4,527	61	76	25.41	30.02	−.06	35.6	−.7	62	23	47	5	1	24	39	31	25	65	1.71	+.5	8	6.7	w.	34	se.	4	10	10	8	5.2	6.0	T
Tonopah	6,090	12	20	------	------	------	29.6	------	48	23	36	10	1	23	22	27	24	80	.53	------	6	------	se.	----	------	----	----	----	----	----	----	----
Winnemucca	4,344	18	56	25.59	30.08	−.01	26.2	−7.3	47	17	39	−13	1	14	41	25	22	79	1.14	+.2	8	8.5	ne.	32	nw.	14	7	10	11	6.2	11.8	T
Modena	5,473	10	43	24.58	30.02	−.02	29.6	−1.4	58	23	41	−9	1	18	37	26	20	68	.36	−.6	7	9.6	w.	32	s.	7	11	6	11	5.0	3.1	T
Salt Lake City[1]	4,227	32	46	25.72	30.07	−.01	30.7	−3.1	51	28	40	7	10	22	26	27	23	73	1.12	------	9	9.0	se.	33	s.	4	6	8	14	6.7	8.8	.0
Grand Junction	4,602	60	68	25.38	30.04	.00	30.1	−2.8	53	25	40	−2	2	20	32	26	19	65	.66	+.1	5	5.6	nw.	28	w.	7	11	7	10	4.9	3.7	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, February 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min.÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Plateau							**29.7**	**−2.9**										**72**	**1.27**	**−0.2**										**7.6**		
Baker	3,471	48	53	26.39	30.05	−0.07	26.2	−2.8	45	27	35	3	19	17	28	25	21	75	.88	−.4	15	7.0	se.	26	sw.	17	1	5	22	8.7	18.5	1.2
Boise	2,739	79	87	27.16	30.09	−.03	32.4	−2.4	51	28	41	5	7	24	25	29	23	68	1.44	.0	14	6.8	se.	23	se.	17	1	11	16	7.5	9.3	.0
Pocatello	4,477	60	68	25.42	30.07	−.03	26.4	−2.5	46	25	35	−6	20	18	35	24	19	70	1.80	+.5	14	11.5	se.	36	w.	14	5	10	13	6.9	15.7	T
Spokane	1,929	101	110	27.87	29.97	−.12	28.6	−2.7	48	24	36	−2	8	21	26	27	23	76	1.49	−.3	13	7.5	s.	27	s.	17	5	7	16	7.1	16.2	1.6
Walla Walla	991	57	65	28.89	29.99	−.12	34.6	−2.5	54	22	42	0	1	27	38	31	26	72	.97	−.8	10	6.4	s.	30	w.	17	2	6	20	8.3	7.6	.0
Yakima	1,076	58	67	28.79	29.97	------	30.0	−4.5	56	21	40	0	9	20	32	28	22	70	1.03	.0	6	4.8	nw.	23	nw.	17	3	13	12	6.9	13.4	.0
North Pacific Coast Region							**41.8**	**−0.3**										**80**	**6.57**	**+1.1**										**8.6**		
North Head	211	11	56	29.71	29.94	−.12	42.7	−.3	58	24	47	31	1	38	15	40	38	85	8.02	+.6	23	18.7	e.	70	s.	16	0	8	20	8.4	2.3	.0
Seattle	125	90	321	29.77	29.90	−.16	41.4	+.3	60	23	46	29	1	36	22	38	34	77	6.78	+2.9	17	11.3	se.	45	s.	4	1	9	18	7.7	8.2	.0
Tatoosh Island	86	10	54	29.76	29.86	−.14	40.5	−.5	52	23	44	32	1	37	11	38	36	84	10.00	+.6	21	16.3	e.	69	s.	16	1	5	22	8.6	3.3	.0
Medford [1]	1,329	29	58	28.59	30.03	------	40.6	------	66	23	49	25	15	32	36	37	32	75	3.23	+.9	13	------	nw.	----	----	---	1	5	22	8.6	2.8	.0
Portland, Oreg	153	68	106	29.81	29.97	−.11	41.8	−.3	60	23	47	19	1	36	21	39	36	80	6.34	+1.0	21	7.0	se.	26	sw.	17	0	3	25	9.2	15.9	.0
Roseburg	510	45	76	29.46	30.02	−.08	42.8	−.6	57	11	50	28	15	35	27	40	36	79	5.07	+.6	23	4.4	sw.	24	sw.	4	1	2	25	9.3	1.3	.0
Middle Pacific Coast Region							**47.0**	**−2.8**										**72**	**6.23**	**+1.2**										**6.7**		
Eureka	62	73	89	30.00	30.07	−.04	45.8	−1.4	62	28	52	33	7	40	23	43	39	77	5.41	−1.1	18	8.4	se.	32	n.	14	3	7	18	7.8	.0	.0
Redding [1]	722	20	34	------	------	------	44.3	−5.4	66	22	52	30	8	37	25	40	33	67	8.44	+1.8	13	7.7	nw.	35	s.	1	2	6	20	8.3	4.3	.0
Sacramento	66	92	115	30.00	30.08	−.01	48.2	−1.9	66	22	56	33	9	41	24	44	39	72	6.18	+3.2	11	7.1	n.	25	se.	4	12	5	11	5.0	.0	.0
San Francisco	155	112	132	29.89	30.06	−.04	49.9	−2.3	65	22	55	40	8	44	19	46	41	73	4.88	+1.0	15	7.6	w.	30	s.	13	9	7	12	5.8	.0	.0
South Pacific Coast Region							**53.6**	**−0.3**										**70**	**4.85**	**+2.7**										**5.5**		
Fresno	327	97	105	29.73	30.10	+.02	51.0	−.1	75	23	60	33	9	42	29	46	41	70	2.46	+1.0	9	6.2	nw.	24	se.	6	8	8	12	5.9	.0	.0
Los Angeles	338	159	191	29.70	30.07	+.01	55.3	−.2	76	28	63	42	8	48	28	48	42	67	7.87	+4.8	7	6.3	ne.	22	se.	14	13	3	12	5.0	.0	.0
San Diego	87	62	70	29.97	30.07	+.01	54.4	−.7	69	22	61	41	27	48	22	49	45	73	4.22	+2.2	9	6.7	nw.	24	s.	6	13	3	12	5.5	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.94	30.03	------	74.2	−.7	86	26	79	66	2	69	16	----	----	----	1.33	−1.4	11	10.7	e.	27	e.	13	6	17	5	4.9	.0	.0
Panama Canal																																
Balboa Heights	118	6	92	------	[3]29.85	−.01	80.2	−.1	91	9	89	68	4	71	21	----	----	[3]75	.56	−.1	6	------	nw.	23	n.	7	5	23	0	4.8	.0	.0
Cristobal	36	6	97	------	[3]29.89	.00	81.7	+.9	87	9	86	75	1	78	11	74	72	[3]74	.46	−1.0	8	------	n.	24	n.	11	8	18	2	5.0	.0	.0
Alaska																																
Fairbanks	454	11	87	[3]29.34	[3]29.92	------	-10.7	------	26	7	0	−50	18	-22	36	−8	−12	79	.54	------	12	3.4	w.	16	sw.	7	4	9	15	7.2	9.6	52.2
Juneau	80	96	116	[3]29.61	[3]29.70	------	29.4	------	45	24	33	10	2	26	13	27	20	68	3.75	------	18	9.3	s.	46	ne.	2	4	3	21	7.9	54.3	7.0
Hawaiian Islands																																
Honolulu	38	86	100	[3]29.96	[3]30.00	------	70.4	−.4	81	19	74	58	11	66	14	65	62	76	5.77	+2.0	14	10.0	e.	30	e.	16	4	13	11	6.6	.0	.0

[1] Observations taken at airport.
[3] Observations taken bihourly.
[4] Pressure not reduced to mean of 24 hours.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, February 1937*

Station	Altitude above mean sea level Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Breton Island	48												
Halifax, Nova Scotia	88												
Yarmouth, Nova Scotia	65												
Charlottetown, Prince Edward Island	38												
Chatham, New Brunswick	28												
Father Point, Quebec	20	29.88	29.91	−0.07	19.9	+8.4	26.9	12.9	38	−6	2.84	+0.63	25.6
Quebec, Quebec	296												
Doucet, Quebec	1,236												
Montreal, Quebec	187												
Ottawa, Ontario	236												
Kingston, Ontario	285	29.64	29.97	−.07	25.4	+7.6	32.0	18.9	52	2	1.79	−.75	7.7
Toronto, Ontario	379	29.55	29.98	−.06	27.9	+6.4	33.8	22.0	50	5	2.21	−.40	3.9
Cochrane, Ontario	930												
White River, Ontario	1,244	28.50	29.85	−.16	11.0	+10.8	23.2	−1.2	41	−30	2.97	+1.45	19.6
London, Ontario	808				25.0		31.8	18.2	54	1	2.48		9.2
Southampton, Ontario	656	29.21	29.95	−.07	24.4	+4.5	30.6	18.2	52	0	1.88	−1.02	14.1
Parry Sound, Ontario	688												
Port Arthur, Ontario	644												
Winnipeg, Manitoba	760	29.10	29.98	−.12	2.8	+4.4	12.1	−6.5	34	−33	1.18	+.20	11.8
Minnedosa, Manitoba	1,690	28.07	30.00	−.09	2.8	+5.5	12.3	−6.6	34	−30	.93	+.32	9.3
Le Pas, Manitoba	860												
Qu'Appelle, Saskatchewan	2,115	27.59	29.96	−.12	2.8	+3.4	12.1	−6.5	37	−32	.73	.00	7.3
Moose Jaw, Saskatchewan	1,759				4.7		14.8	−5.4	40	−32	.27		2.7
Swift Current, Saskatchewan	2,392	27.32	30.00	−.07	4.8	−3.2	13.8	−4.1	38	−30	.38	−.36	3.8
Medicine Hat, Alberta	2,365												
Calgary, Alberta	3,540												
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450												
Battleford, Saskatchewan	1,592	28.19	30.05	−.04	−2.8	−2.9	10.3	−16.0	35	−43	.54	+.17	5.4
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262												
Victoria, British Columbia	230												
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20												
Prince Rupert, British Columbia	170												
St. George's, Bermuda	158		29.98	−.13	61.7	−.1	67.0	56.4	73	46	5.78	+1.08	.0
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Cape Race, Newfoundland	99				23.3		31.8	14.8	45	−7	7.26		20.4
Sydney, Cape Breton Island	48	30.07	30.12	+0.19	24.6	+4.1	33.4	15.8	52	−5	4.24	−0.86	9.6
Halifax, Nova Scotia	88	29.95	30.06	+.09	28.2	+6.4	36.2	20.2	51	4	5.26	−.51	3.1
Yarmouth, Nova Scotia	65	30.15	30.22	+.22	31.6	+5.3	39.0	24.1	51	10	4.15	−1.01	9.3
Charlottetown, Prince Edward Island	38	30.10	30.14	+.18	21.7	+4.7	29.8	13.5	48	−6	4.24	+.28	17.9
Chatham, New Brunswick	28	30.07	30.11	+.14	16.0	+6.2	27.3	4.7	43	−20	2.01	−1.58	10.1
Doucet, Quebec	1,236				2.4		21.4	−16.5	42	−54	4.44		43.2
Calgary, Alberta	3,540	26.25	30.18	+.15	.5	−7.9	9.4	−8.5	41	−32	1.68	+1.15	16.8

TABLE 4.—*Severe local storms, February 1937*

(Compiled by Mary O. Souder from reports submitted by Weather Bureau officials)

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Livingston, Mont	3-4					Straight-line wind	This storm reported by the United States airway station as having wind varying between 40 to 80 miles an hour occurring between 7:45 a. m., Jan. 3 and 5 p. m., Jan. 4.
Eureka, Calif	4	A. m				Wind	Houses unroofed, trees and telephone poles blown down, and other damage reported.
Cortez, Fla., and vicinity	4	P. m	50	0	$6,000	Tornado	Property damaged, path 400 yards long.
San Francisco, Calif., and vicinity	4					Wind and rain	Trees uprooted, fences blown down, and roofs carried away. In coastal sections, near here, winds of 60 miles an hour were recorded.
South Dakota, western and northern portions.	6					Wind	Brisk northwest wind, accompanied by subzero temperatures, hampered railways and motor traffic by blinding snow. Number of accidents reported because of reduced visibility.
Yuma and Maricopa Counties, Ariz.	6-7				52,000	Heavy rain and flood.	At Parker, in extreme northwestern Yuma County, the Bush pontoon bridge was destroyed. At the Bartlett Dam site, in northeastern Maricopa County on the Verde River, 2 small bridges, a storage shed, and several trucks were washed away. A gas line in the Salt River bed, near Phoenix, undermined by water and broke.
San Diego County, Calif	6-7			1	250,000	Heavy rain	In the vicinity of Descanso, 40 miles northeast of San Diego, 8.2 inches occurred in the 24-hour period ending 7 a. m., on Feb. 7. Considerable loss to gardners, dairymen and dwellers in river bottoms and lowlands. Many roads washed out and bridges carried away or made unsafe. Travel between San Diego and points north suspended by boat or airplane until temporary repairs could be effected.
Pueblo, Colo	7	2:40 p. m				Wind and dust	Storm lasted more than 2 hours with wind of 36 miles an hour recorded. 4 motor accidents, because of poor visibility.

TABLE 4.—*Severe local storms, February 1937*—Continued

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Grand Rapids, Mich	7					Glaze	Bus schedules delayed; numerous accidents, some serious, reported.
Lansing, Mich	7–8					do	Ice on exposed objects; highway traffic hazardous.
Milwaukee and other points in southern and eastern Wisconsin.	7–8					Snow, sleet, and dust.	Rain, froze as it fell on the afternoon of the 7th. Within 2 hours Milwaukee was covered with ice. Highway bus and train service was delayed. Dust covered the area between La Crosse, Fond du Lac, and Rhinelander and at Antigo and Marshfield. In the Rice Lake area, 12 inches of snow blocked all roads except main highways. More than 80 persons injured.
Montana, western portion	7–13					Snow	A series of snowslides blocked traffic on railroads through the Bitterroot Mountains.
Fagus, Mo	8	1 p. m.	200	0	$4,000	Tornado	Funnel-shaped cloud reported. 6 persons injured and property damaged, only a few buildings in town escaping the storm.
Evansville, Ind	8				8,000	Wind	Considerable property damaged.
Canton, N. Y., vicinity of	8					Thunderstorm	Barn destroyed by lightning.
Virginia, coastal region	8				36,000	Straight-line wind	3 barges lost off the Virginia coast.
Bridgeport, Ala	9	P. m.			85,000	Wind	12 persons injured; property damaged.
Livingston, Mont., vicinity of	9–12					Straight-line wind	Storm began at 7 p. m., of the 9th and lasted until 2 p. m., of the 12th, strongest winds occurring between 11 p. m., of the 9th to noon of the 10th. The only damage reported was that the high steel tower of the United States airway radio station was blown down.
Eufaula, Ala	10	A. m.			1,000	Wind	8 persons injured; property damaged.
South Dakota, eastern portion	12–15			1		Blizzard	Strong north to northwest winds accompanied by drifting snow. Schools closed; train and bus service stopped. Near Deadwood, an elderly man, caught in the storm, apparently lost his way and died of exposure.
San Francisco, Calif	13					Wind and rain	Considerable damage reported in various parts of the city.
Baca County, Colo	14–17					Wind and dust	Strong winds caused much soil erosion and kept this vicinity in semidarkness for periods from 7 to 20 hours during each of the 4 days; highway traffic paralyzed and plane service disrupted during the height of the "blow".
Washington, western portion	16–17					Wind and rain	Storm was general during the night of the 16th and early morning of the 17th. Damage to small boats at Olga in Rosarie Strait. Collision of 2 steamers in the Columbia River at time of high wind and heavy rain, but not directly attributed to the weather.
Havre, Mont	17	10 a. m.				Wind and dust	Dust in the air from 10 a. m. to after dark. The sky was grayish tan most of the day. Visibility reduced to from 1¼ to 3 miles between 10:45 a. m. and 5 p. m.
Greene, Christian, Webster, Wright, and Douglas Counties, Mo.	20	4–5 p. m.	333–440	0	200,000	Tornadoes with hail.	Well-defined funnel-shaped or twisting clouds reported. The paths of these 3 tornadoes were about 10 miles apart and ran parallel in an almost southwest to northeast direction. 13 persons were injured, 2 critically, 55 homes damaged or destroyed and as many or more barns, garages, and outbuildings. Trees, telephone and telegraph poles and wires blown down. An apple orchard of 1,000 fine trees badly damaged. Numerous livestock and poultry killed. Paths 10 to 30 miles long.
Vicksburg, Miss., 3 miles north	20	5–5:30 p. m		0		Tornado	Considerable damage to buildings and a lumberyard.
Dubach, La., and vicinity	20		400	0	50,500	do	This storm moved east-northeastward through Lincoln Parish from the vicinity of Sugar Creek to the extreme northeast corner of the parish 15 persons were injured. Loss of $30,000 in timber; $20,000 property damage, and $500 livestock loss. Path 35 miles long.
Adams County, Miss., southwestern portion.	20		300	0	800	do	Property damaged. Path of this tornado indefinite.
Wisconsin, eastern and southern section.	20–21				200,000	Rain and flood	Flooding caused by heavy rains.
Charlotte, N. C	21	5:37 p. m.				Severe line squall	Property damaged and 1 person seriously injured. Path several blocks wide and 3 miles long.
Greensboro, N. C., and vicinity	21	7 p. m.	200	0	50,000	Tornado	This storm developed 4 miles south-southeast of this station and moved northeastward showing devastating force in a strip of woodlands and seriously injuring 2 persons. There were evidently 2 parallel paths, 4 and 16 miles, respectively, east of the main one with some cyclonic circulation and with forces sufficient to uproot trees and wreck buildings of poor construction.
Mechanicsville, Va., vicinity of	21	10 p. m.	83		2,000	Tornadic winds	Shed unroofed; barn demolished and 3 cows killed.
Cleveland, Ohio, and vicinity	21	P. m.			3,000	Thundersquall and hail.	Winds of gale force reported at intervals between 8 p. m. and midnight. Damage mainly in western and southwestern suburbs and beyond. Several buildings wrecked, poles snapped, trees uprooted, and automobiles damaged.
Florida, Odessa-Lutz section north of Tampa.	21		33–66	0	(1)	Tornado	This disturbance began near Wall Springs and south of Tarpon Springs, moving east-northeasterly, ending near St. Leo. Damage to buildings and loss to citrus fruits. Path 30 miles long.
Duluth, Minn	21				2,000	Wind	Average wind velocity of 37 miles with a maximum of 53 miles per hour recorded. Windows broken and signs blown down.
St. Louis, Mo	21					do	Heavy damage reported. Windows broken, trees uprooted, poles and smokestacks down and 1 person injured.
Columbus, Ohio,[2] and vicinity	21				35,000	Tornadic winds	Rain, hail and snow accompanied this storm with considerable damage north of Columbus. Roofs blown off and poles down. In Delaware, Ohio, alone, damage was estimated at $35,000.
Maryland	21–22	11:30 p. m. of 21st–12:30 a. m. of 22d.		0	100,000	Tornado	Disturbance began in Greenock, Bristol, Tracys Landing, and Jewell, then over Chesapeake Bay, affecting Chester and Eastern Neck to southwestern Kent County on the north side of Chester River. More than 20 tobacco barns blown down, with $50,000 loss to tobacco crop. Houses damaged, many trees uprooted, and poles down. Path narrow and 40 miles long.
Wilkes-Barre, Pa., and vicinity	21–22	P. m.				Wind and rain	Trees and wires blown down. Considerable damage to telegraph lines reported from the Bloomsburg division of the Delaware, Lackawanna & Western R. R.
New York, central and northern portions.	22	A. m.				Snow	Considerable damage to power and telephone lines. Automobile traffic delayed.
Ann Arbor, Mich.,[3] vicinity of	22					Wind	About 20 acres of this community struck by a severe wind storm. A garage was demolished and the car left untouched. A few timbers lodged in the roof of the house. The roof torn from a cement-block garage and carried 200 feet to a driveway, where it caved in the side of a car parked there. Many large wood splinters driven, like arrows, into the walls of a house.
Calumet, Mich	22					Snow	14 inches of snow measured. Train service at standstill and highway traffic crippled. One-way traffic the rule on all highways opened at all.
Beadle County, S. Dak	23					Dust and wind	Storm lasted all day with wind west-northwest. More severe in the vicinity of Wolsey and Wessington. Visibility reduced to 440 yards and less from 1 to 4 p. m.

[1] Over $15,000.

[3] From press reports.

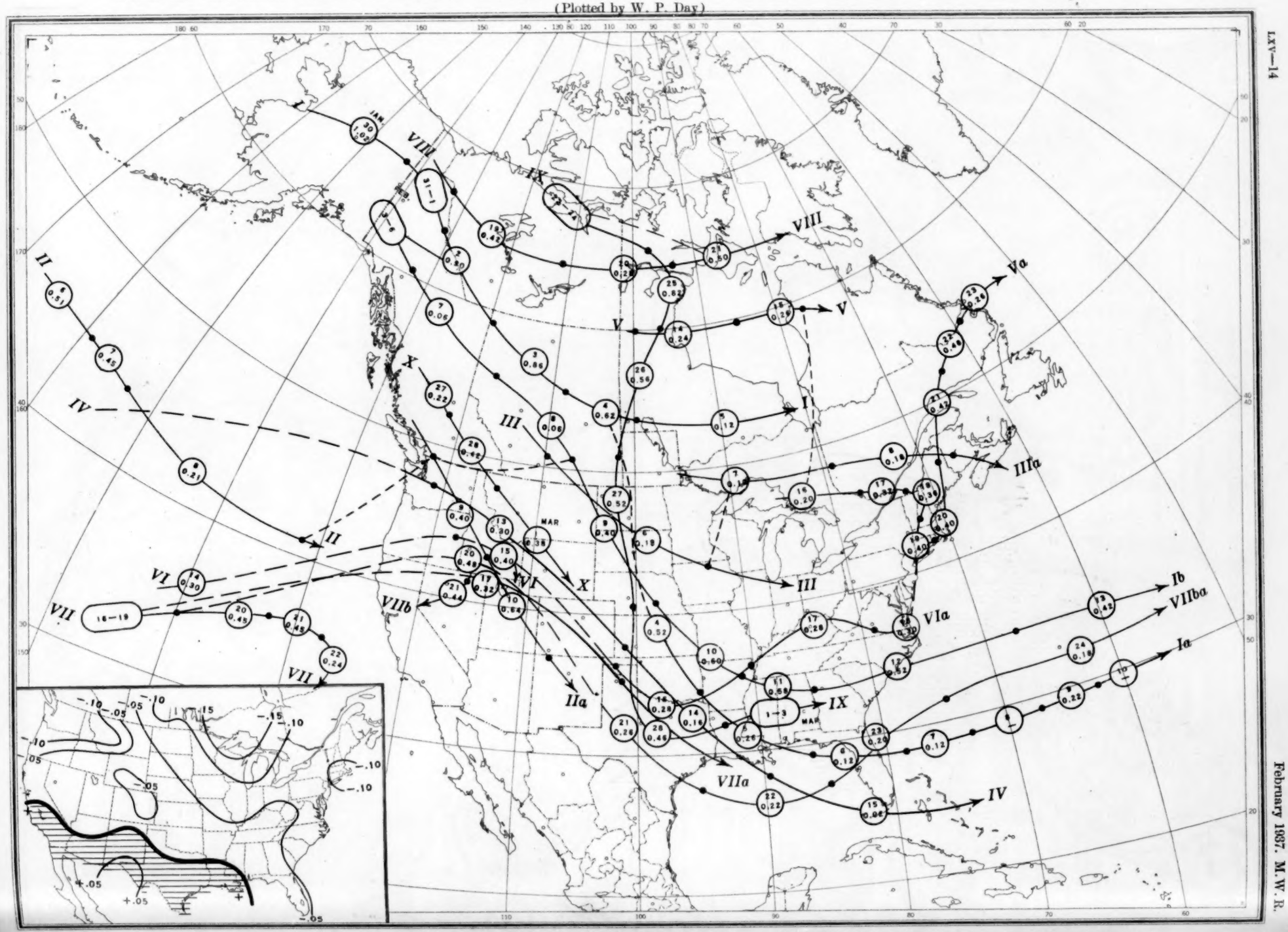
Chart I. Departure (°F.) of the Mean Temperature from the Normal, February 1937

Chart I. Departure (°F.) of the Mean Temperature from the Normal, February 1937

Shaded portions show excess (+)
Unshaded portions show deficiency (−)
Lines show amount of excess or deficiency
Statute Miles
Kilometers

Chart II. Tracks of Centers of Anticyclones, February 1937. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by W. P. Day)



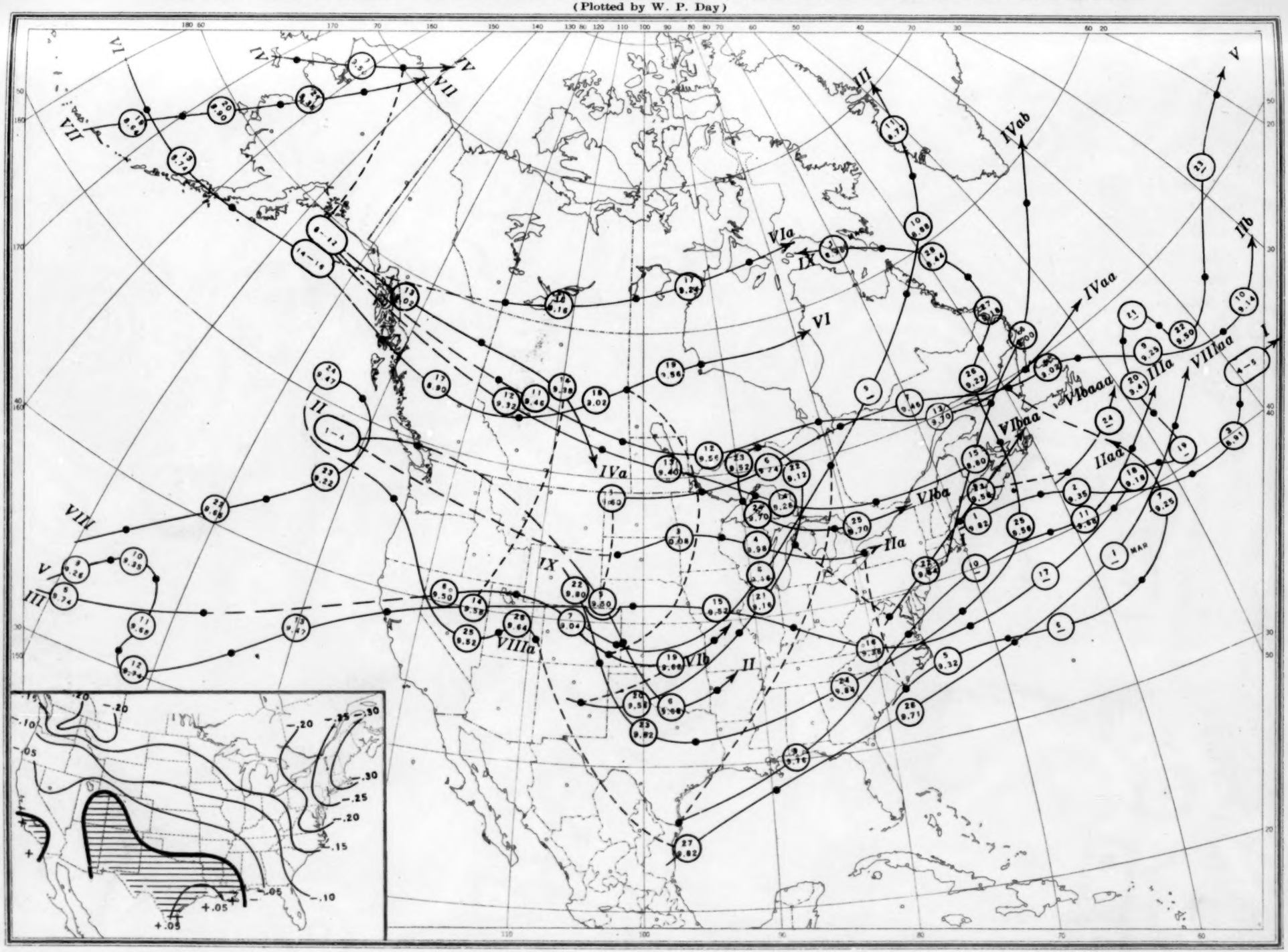
Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, February 1937. (Inset) Change in Mean Pressure from Preceding Month

Circle indicates position of anticyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 8 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, February 1937. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by W. P. Day)



Circle indicates position of cyclone at 8 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 8 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, February 1937

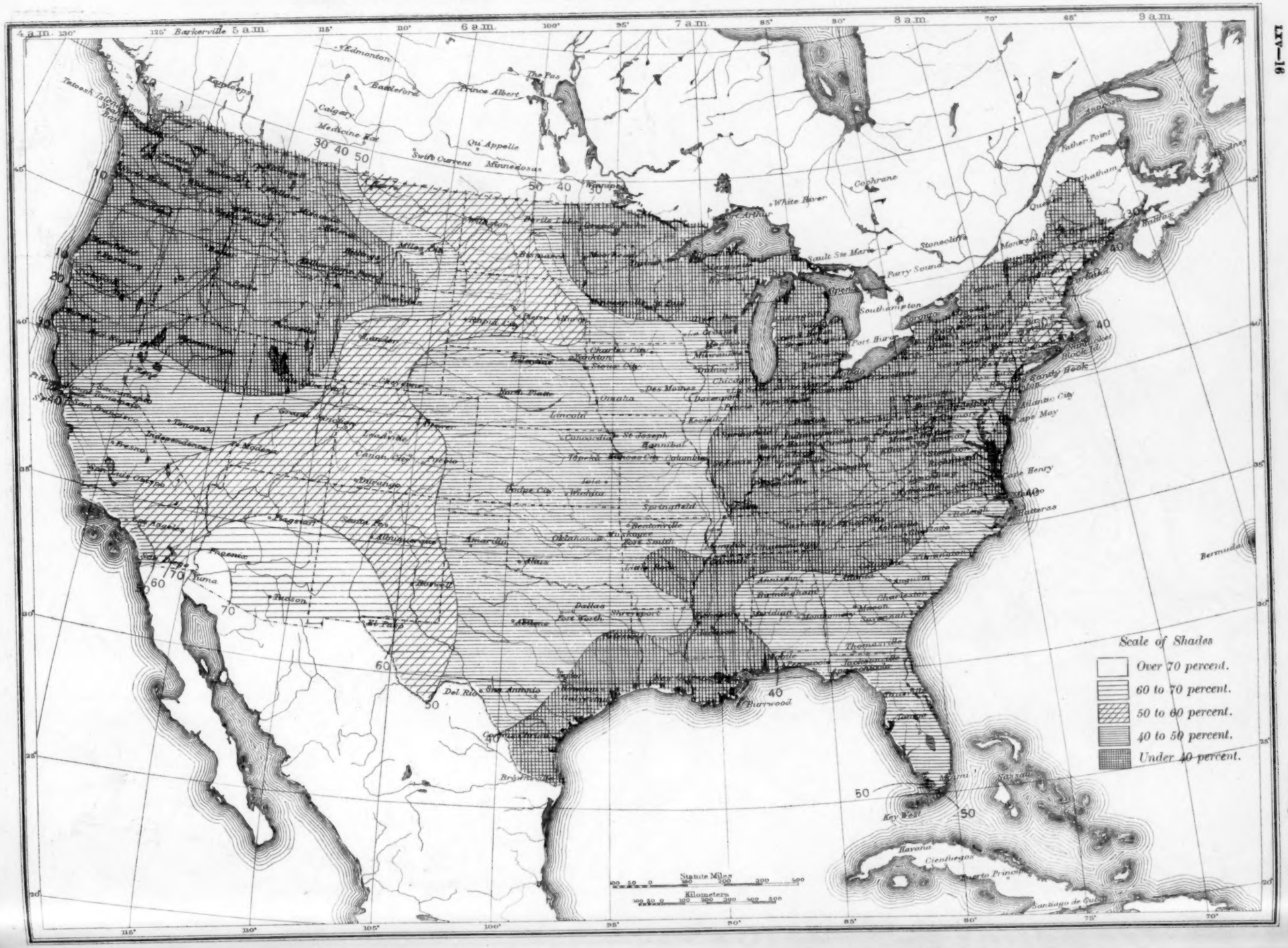


Chart V. Total Precipitation, Inches, February 1937. (Inset) Departure of Precipitation from Normal

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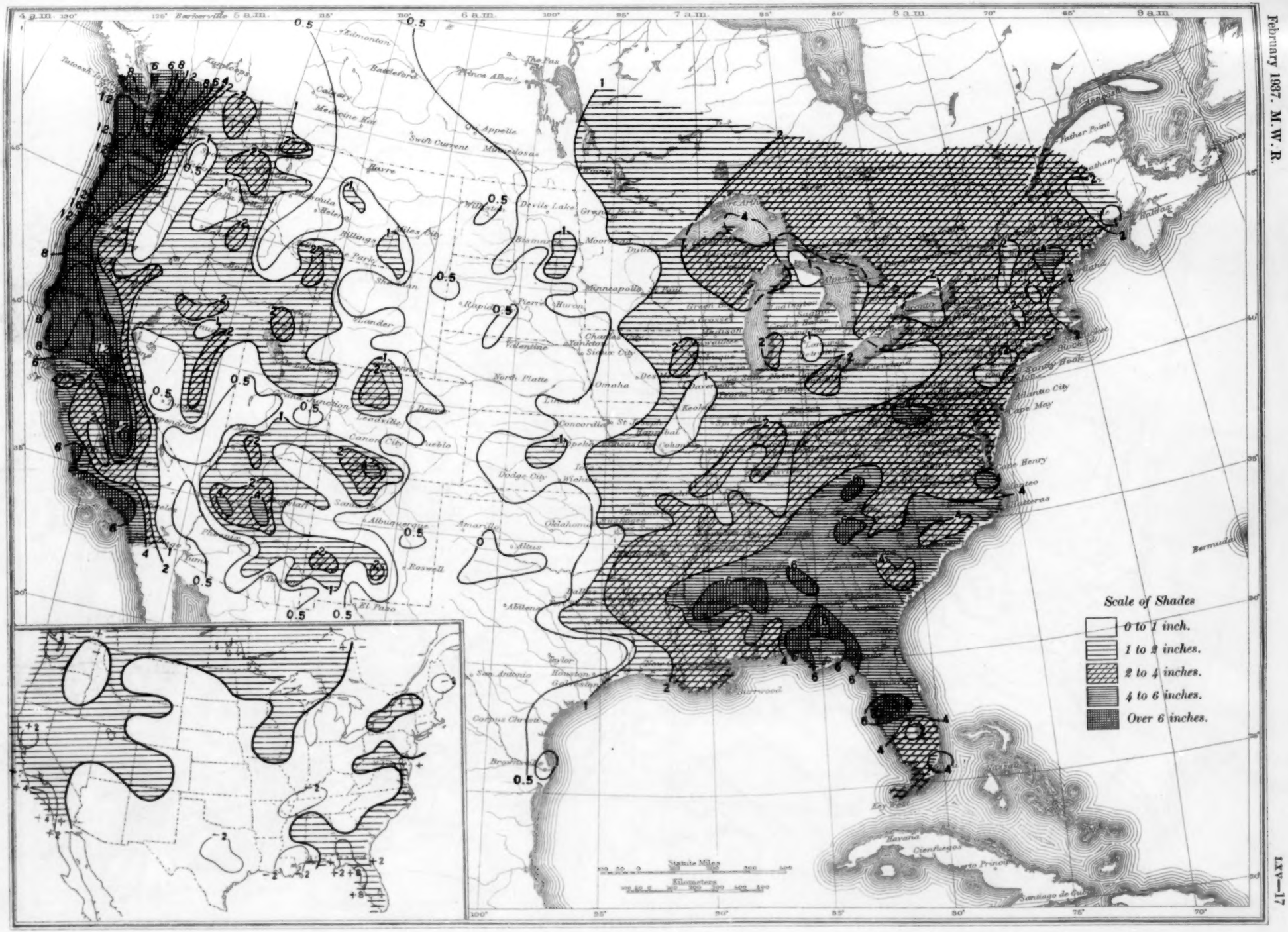

Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, February 1937

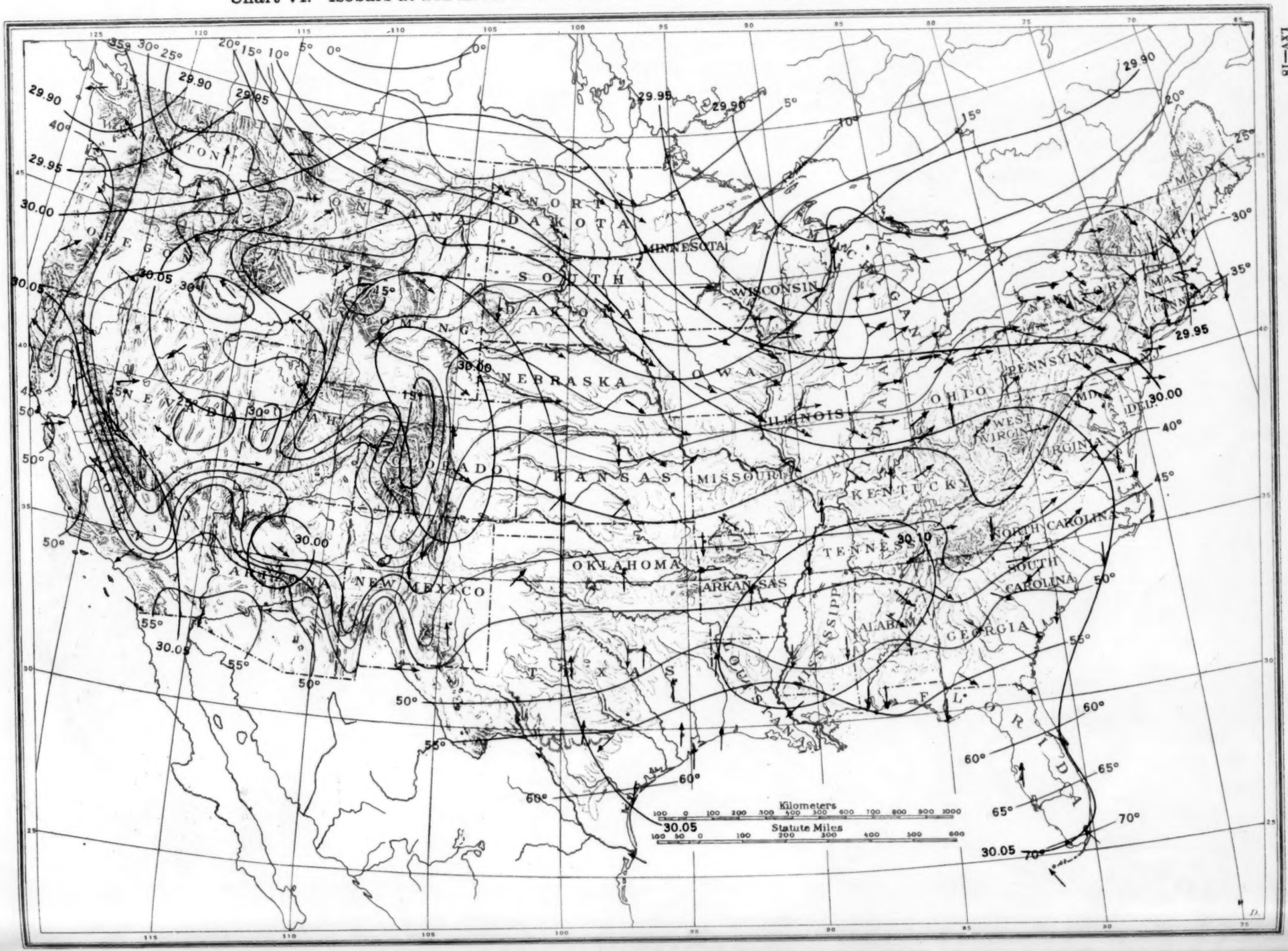

Chart VII. Wind Roses for Selected Stations, February 1937

(Plotted by W. W. Reed)

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(Plotted by W. W. Reed)

Chart VIII. Total Snowfall, Inches, February 1937. (Inset) Depth of Snow on Ground at 7:30 p. m., Monday, March 1, 1937

Chart IX. Weather Map of North Atlantic Ocean, February 5, 1937
(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart IX. Weather Map of North Atlantic Ocean, February 5, 1937
(Plotted from the Weather Bureau Northern Hemisphere Chart)

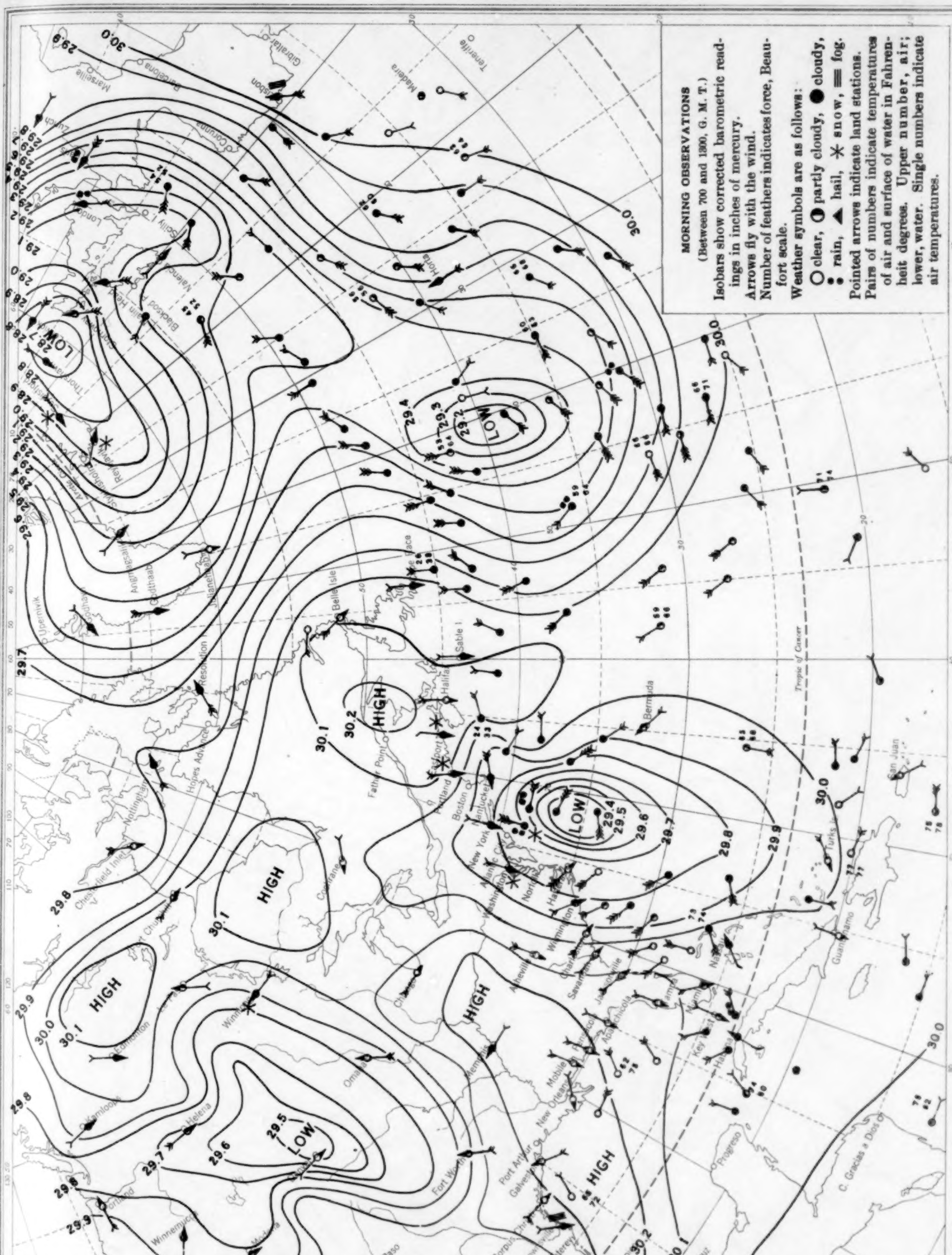

Chart X. Weather Map of North Atlantic Ocean, February 6, 1937

(Plotted from the Weather Bureau Northern Hemisphere Chart)

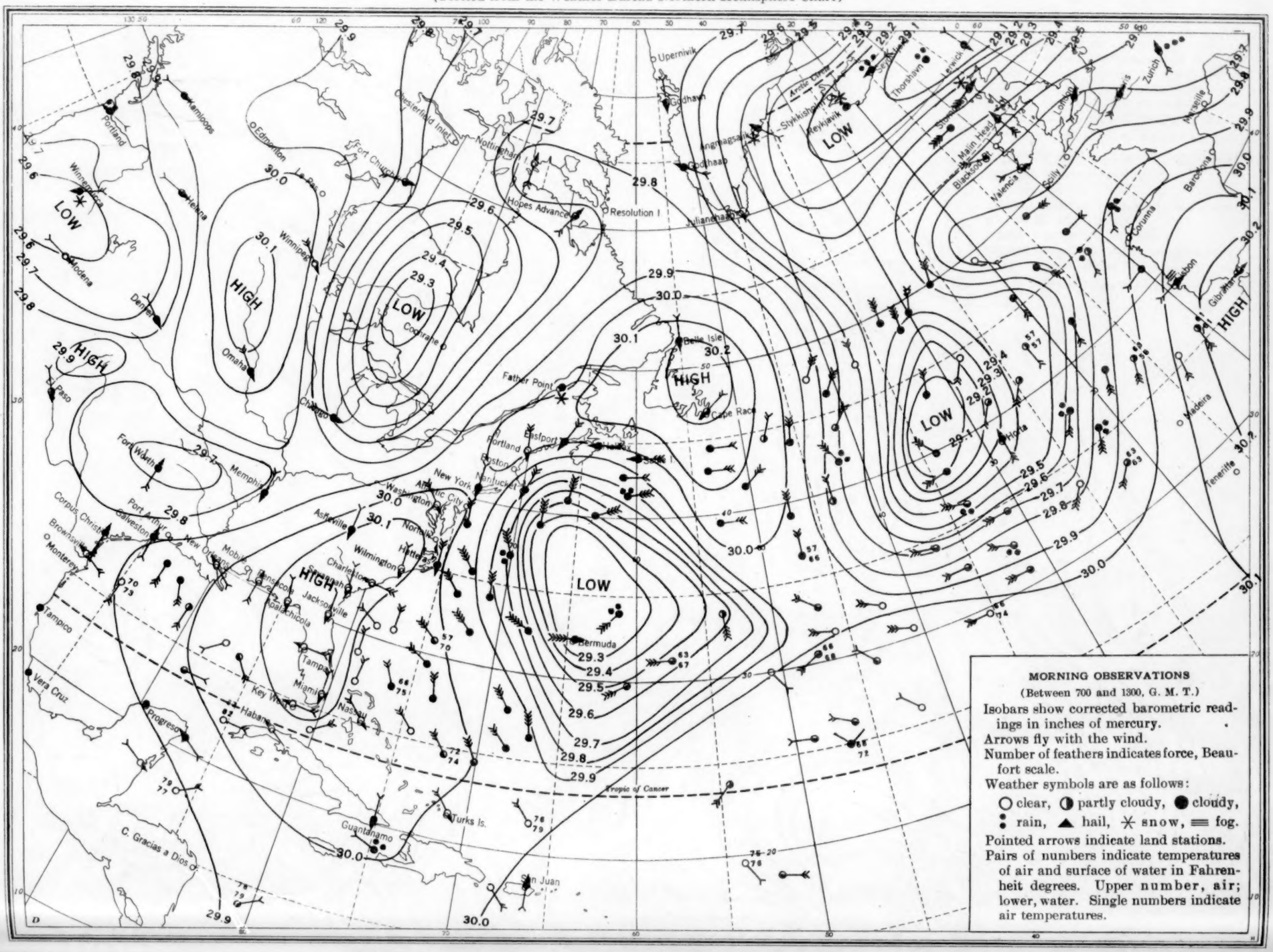

Chart XI. Weather Map of North Atlantic Ocean, February 17, 1937

(Plotted from the Weather Bureau Northern Hemisphere Chart)
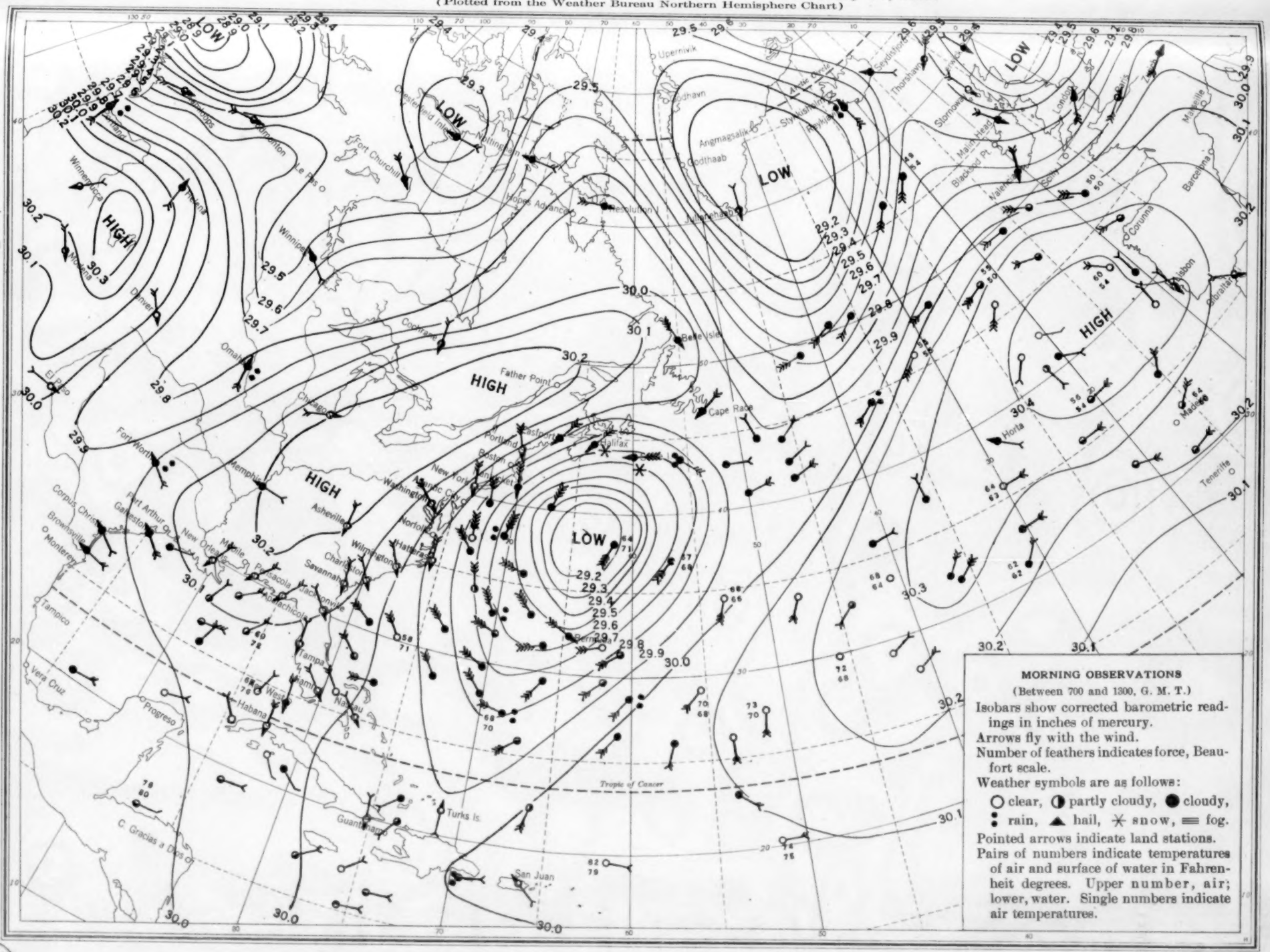
Chart XI. Weather Map of North Atlantic Ocean, February 17, 1937
(Plotted from the Weather Bureau Northern Hemisphere Chart)